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Composition B Damage Studies

by
A. I. Atwood
K. P. Ford
I. Purifoy
C. J. Wheeler
E. Woods
Combustion Sciences and Propulsion Branch
Energetics Research Division

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NAVAL AIR WARFARE CENTER WEAPONS DIVISION
China Lake, CA 93555-6100

FOREWORD

This report describes a study conducted by the Combustion Sciences and Propulsion Branch to examine the friability characteristics of cylindrical and spherical Composition B explosive (CompB) samples. The study, conducted from August through December 2013, included closed bomb combustion and dry screening of the damaged CompB samples. The work was funded by Lawrence Livermore National Laboratory. The screened size fractions of the damaged spherical samples were returned to Livermore for further testing.

This report was reviewed by the authors for technical accuracy. The findings of this study are preliminary in nature and the report is released at the working level.

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A. I. Atwood, K. P. Ford, I. Purifoy, C. J. Wheeler, and E. Woods

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14. ABSTRACT

(U) The shotgun/friability test was used to evaluate the vulnerability of the melt cast explosive, Composition B, to mechanical insult. Cylindrical and spherical configurations were damaged using an 18-millimeter (mm) smooth bore gun. Despite the lack of optimum combustion performance, the experiment was useful in demonstrating the effects of impact damage on the energetic material. The recovered spherical debris was dry screened with the sample distribution resulting in a bimodal distribution. The individual size fractions of the explosive were returned to Lawrence Livermore National Laboratory for further analysis.

15. SUBJECT TERMS
Closed Bomb, Composition B Explosive (CompB), Cylinders, Energetic Materials, Melt Cast, Shotgun/Friability Testing, Spheres

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BACKGROUND

Shotgun/friability testing has been used to examine the damage vulnerability of an energetic material to mechanical insult. The test is used in the evaluation of deflagration-to-detonation transition (DDT) potential (Reference 1) and in hazard classification testing (Reference 2).

Shotgun testing in the United States was originally designed to evaluate the damage thresholds of viscoelastic propellants and their potential to DDT. It has been used to determine the surface area increase as a function of impact velocity in these materials. The test has been extended to the evaluation of explosive formulations more recently (Reference 3).

The successful modeling of mechanically induced brittle fracture is currently under investigation at Lawrence Livermore National Laboratory (LLNL) and this effort will provide data to support the ongoing studies to understand impact fracture and fragmentation.

OBJECTIVE

The objective of this study was to generate and examine the mechanical damage of Composition B explosive (CompB) in two geometric configurations for LLNL. The effort was designed to gain insight into the mechanisms of brittle fracture resulting from mechanical insult to the explosive and to provide validation data for ongoing fracture models under development.

APPROACH

This study included a two part approach.

Part I of the study was to perform traditional shotgun/friability testing with 18-millimeter (mm) diameter cylindrical CompB samples. The samples were fired from a smooth bore, 18-mm gun against a steel target at various velocities. The resulting debris was collected and fired in a manometric closed vessel. The pressure–time history was recorded and an analysis of the data performed to evaluate both the maximum dp/dt and burn area increase as a function of impact velocity.

Part II of the study was performed with 18-mm diameter spherical CompB samples that were again fired from the 18-mm gun at various velocities. The resulting debris was

dry screened into size fractions from 3,360 to 106 micrometers (µm). These samples were then returned to LLNL for further study at that facility.

EXPERIMENT

SHOTGUN

A schematic of the Naval Air Warfare Center Weapons Division (NAWCWD) 18-mm high velocity impact device is shown in Figure 1. The device was designed and built by Safety Management Services. The breech of the gun barrel was designed to operate with either powder or gas driven actuation. The 18-mm barrel was fired using nitrogen in this study. The device incorporates a 2.3-liter accumulator tank with an air actuated ball valve. This tank enables the operator to vary the propulsion gas pressure and thus the velocity of the explosive sample. Impact velocities of 89 to 435 feet per second (ft/s) (27.13 to 132.59 meters per second [m/s]) were achieved in this study.

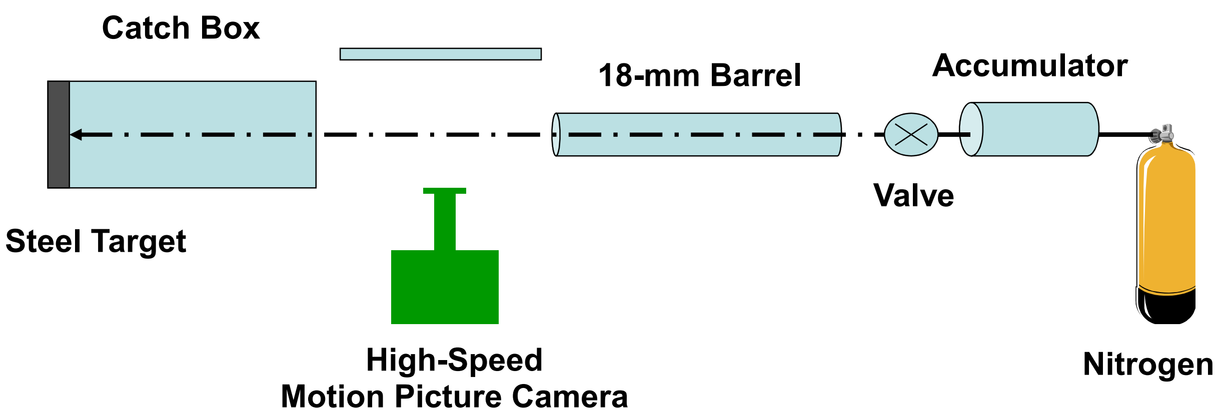


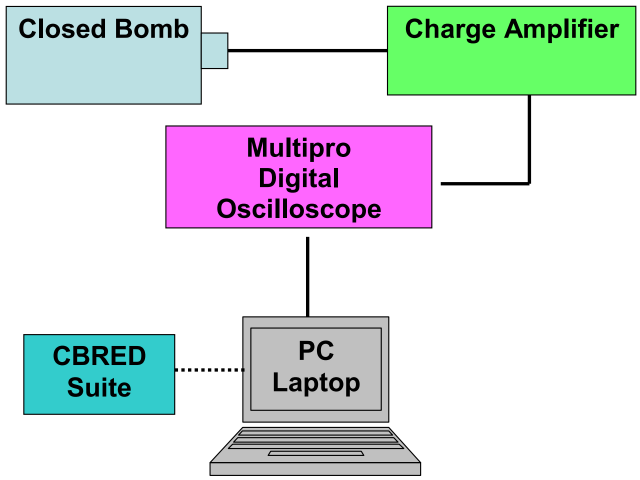
FIGURE 1. Schematic of the 18-mm Impact Device Used for the CompB Friability Study.

CLOSED BOMB

A 200-cubic centimeter (cm^3) Harwood Engineering powder bomb was sleeved to a volume of 137 cm^3 for this study. Ignition of the sample was by means of a Reynolds air bag squib firing into approximately 1.0 gram (g) of DuPont PB smokeless powder acting as an ignition aide. The squib and aide were packaged in a silk bag and the entire ignition unit was similarly bagged with the CompB samples.

A schematic of the closed bomb data acquisition system is shown in Figure 2. Pressure–time data were acquired using a Kistler model 607C4 pressure transducer. The

amplified pressure signal was digitized and recorded on a Nicolet Multipro digital data acquisition system. The pressure–time records obtained from the digital oscilloscope were processed to remove wild points, smoothed using a parametric spline, and differentiated (Reference 4).



CBRED = closed bomb data reduction program, PC = personal computer.

FIGURE 2. Schematic of the Closed Bomb Data Acquisition System.

It was noted that the number of segments selected in the smoothing process had an effect on the maximum dp/dt determined from the shot. The number of segments selected for the parametric spline was varied until the resulting value of maximum dp/dt did not vary more than 5 percent to maintain a constant smoothing contribution.

The closed bomb reduction program, CBRED II, was used to reduce the closed bomb data obtained in this study (Reference 5). Closed bomb reduction transforms a measured pressure–time history into a mass regression rate through application of an equation of state. The CBRED II code utilized the Noble-Abel co-volume equation of state:

$$P(V_s - nw_e) = w_eF$$

where

- P = System pressure
- V_s = System volume
- n = Co-volume
- w_e = Weight of explosive burned
- F = Impetus, f (temperature, molecular weight)

The mixture of gaseous species is treated as a single gaseous species.

The measured pressure–time history from a closed bomb firing is converted to a mass regression rate based on thermochemistry, as determined from a thermochemical equilibrium code (BLAKE in this study) (Reference 6). The mass burning rate (m) of an energetic is the product of the surface area (A_b), the sample density (ρ), and the linear burning rate (r).

$$\dot{m} = \rho r A_b$$

For the undamaged sample, the density and initial burn area are known or calculated, and the linear burning rate as a function of pressure can be determined. Once the linear burning rate has been determined for a formulation, it can then be used as input into the CBRED II program for the damaged sample evaluation. The pressure–time history for the closed bomb firing of the damaged sample is again converted to mass burning rate-time in the program. Referring again to the above equation for the damaged sample, the density (assumed to be unchanged) and linear burning rate are known, and the burn area as a function of time and distance burned can be determined. The surface-to-volume ratio (S/V) of the damaged sample can also be calculated from the burn area data by multiplying the original S/V of the sample by the maximum burn area ratio.

It can be seen from the previous discussion that the closed bomb analysis relies on a sample with good combustion properties. Equilibrium thermochemistry is employed and gaseous combustion products are assumed for the optimal application of the analysis. Good sample integrity (no flaws from manufacturing or deconsolidation during combustion) and uniformity are key to optimal data reduction.

PARTICLE SIZE ANALYSIS

The recovered damaged spherical samples and four of the cylindrical samples were dry screened to obtain an understanding of the particle size distribution of the fragments as a function of impact velocity. The damaged samples were dry screened from 3,360 to 106 µm using a set of 14 screens.

The final screening technique developed included sending the entire damaged sample first through the 355-µm mesh screen. The sample remaining on the top of the 355-µm screen was then sent through the 3360-, 1000-, 840-, 590-, 500-, and 420-µm mesh screens. The sample smaller than 355 µm was sent through the 250-, 212-, and 180-µm screens and the less than 180 µm fraction was sent through the 150-, 125-, and 106-µm mesh screens. It was found that the size fractions below 200 µm required a large amount of agitation in order to achieve particle separation. An alternate method for particle size analysis should be employed to obtain the size fractions below 106 µm.

A shortfall of most size analysis methods, including screening, is that they are based on a spherical particle. The size analysis error will increase as the length to diameter

ratio increases in the fragments generated upon impact. It is assumed that microscopy will be applied to the size fractions at LLNL in order to evaluate the particle morphology.

SAMPLES

Cylindrical and spherical samples of CompB, BAE10E234-007, were received from LLNL for this study. The cylindrical samples, ID C-603, for Part I of the study were sent and tested prior to the spherical, ID C-581, samples of Part II.

The composition of the CompB samples used in this study is shown in Table 1. The formulation was composed of 61 percent cyclotrimethylene trinitramine (RDX) and 38 percent trinitrotoluene (TNT) by weight, melt-cast with 1 percent wax. A density of 1.74 grams per cubic centimeters (gm/cm^3) for the explosive was used in the closed bomb analysis (Reference 7).

TABLE 1. CompB Composition.

Ingredient	Weight Percent
RDX	61
TNT	38
Wax	1

PART I – CYLINDERS

The shotgun/friability cylinders were weighed, measured, and photographed upon receipt prior to testing. A summary of these data can be found in Table 2. Photographs of the undamaged cylindrical CompB samples can be found in Appendix A.

TABLE 2. Undamaged Cylinder Data.

Part No.	Weight, g	Diameter, mm	Length, mm
1	9.8843	17.97	22.77
2	9.9266	17.98	22.79
3	9.9070	17.97	22.74
4	9.8830	17.97	22.70
5	9.9441	17.97	22.74
6	9.8759	17.97	22.72
7	9.9105	17.97	22.74
8	9.8580	17.97	22.71
9	9.9317	17.97	22.74
10	9.9508	17.97	22.74
11	9.9021	17.97	22.68
12	9.9385	17.97	22.74
13	9.9187	17.97	22.73
15	9.9234	17.97	22.72
16	9.9181	17.97	22.70
17	9.8778	17.97	22.72
18	9.8890	17.98	22.72
19	9.8841	17.98	22.71
20	9.8544	17.98	22.78
23	9.8431	17.98	22.72
25	9.9135	17.97	22.72
26	9.8944	17.98	22.73
27	9.9249	17.98	22.72
28	9.9426	17.98	22.79
29	9.9145	17.98	22.71
30	9.9325	17.98	22.72
31	9.9086	17.98	22.72
32	9.8753	17.98	22.71
33	9.8753	17.98	22.74
34	9.8688	17.98	22.75
35	9.8768	17.98	22.68
36	9.8692	17.98	22.74
37	9.8668	17.97	22.72
38	9.8657	17.98	22.72
39	9.8063	17.98	22.66
40	9.8406	17.98	22.71

The friability cylinders were 17.9754 ± 0.0051 mm in diameter and 22.7251 ± 0.0271 mm in length. They weighed 9.8944 ± 0.0335 g. A typical sample is shown in Figure 3.

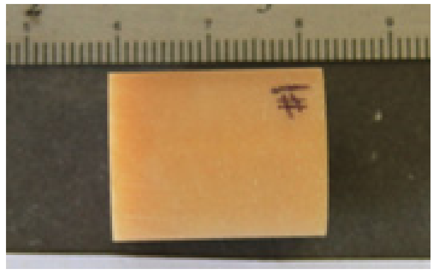


FIGURE 3. Typical Friability Sample
(mm Scale Divisions).

A modified 12-gauge shotgun wad was used as a sabot for the cylinders in the 18-mm damage tests. The sample arrangement is shown in Figure 4.

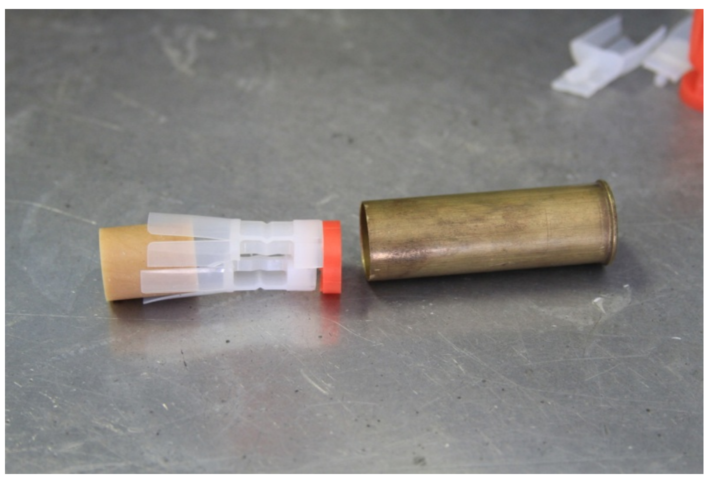


FIGURE 4. 18-mm Arrangement for the Cylindrical Samples.

Small voids, as shown in Figure 5, were observed in a few of the cylindrical samples.

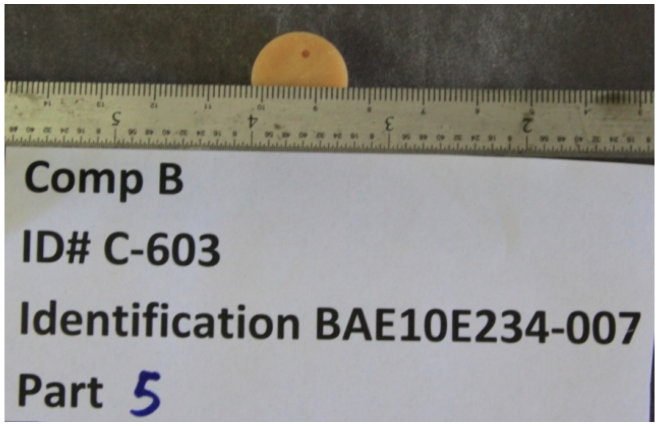


FIGURE 5. Small Void in Cylindrical Sample.

PART II – SPHERES

The shotgun/friability spheres were numbered, weighed, measured, and photographed upon receipt prior to testing. An oily residue was noted on the packing materials of the spheres as shown in Figure 6. Discussions with LLNL indicated that the residue was probably TNT. A summary of these data can be found in Table 3. Photographs of the undamaged spherical CompB samples can be found in Appendix B. The friability spheres were 18.00 ± 0.01 mm in diameter and they weighed 5.2630 ± 0.0066 g. A typical sample is shown in Figure 7.

FIGURE 6. Residue From Spherical CompB Sample.

TABLE 3. Spherical Sample Data.

Part no.	Diameter, mm	Weight, g	Part no.	Diameter, mm	Weight, g
1	18.00	5.2691	25	18.01	5.2654
2	17.99	5.2694	26	18.01	5.2715
3	18.00	5.2634	27	18.01	5.2696
4	17.99	5.2635	28	18.01	5.2689
5	18.01	5.2658	29	18.01	5.2679
6	17.99	5.2655	30	18.01	5.2643
7	18.00	5.2680	31	18.01	5.2720
8	18.01	5.2520	32	18.01	5.2560
9	18.01	5.2628	33	18.00	5.2688
10	18.00	5.2572	34	17.99	5.2653
11	18.00	5.2609	35	17.99	5.2531
12	18.00	5.2673	36	17.98	5.2606
13	17.99	5.2700	37	17.98	5.2520
14	18.00	5.2684	38	17.98	5.2608
15	18.00	5.2647	39	17.98	5.2627
16	18.00	5.2599	40	17.99	5.2589
17	18.00	5.2386	41	17.98	5.2585
18	18.00	5.2656	42	18.02	5.2667
19	18.00	5.2634	43	18.00	5.2682
20	17.99	5.2594	44	18.00	5.2603
21	18.00	5.2549	45	18.00	5.2647
22	18.01	5.2580	46	17.99	5.2660
23	18.00	5.2742	47	18.00	5.2518
24	18.00	5.2676	48	18.00	5.2614

FIGURE 7. Spherical CompB Sample (mm Scale).

The modified 12-gauge shotgun wad was again used as a sabot for the spheres in the 18-mm damage tests. The sample arrangement is shown in Figure 8.

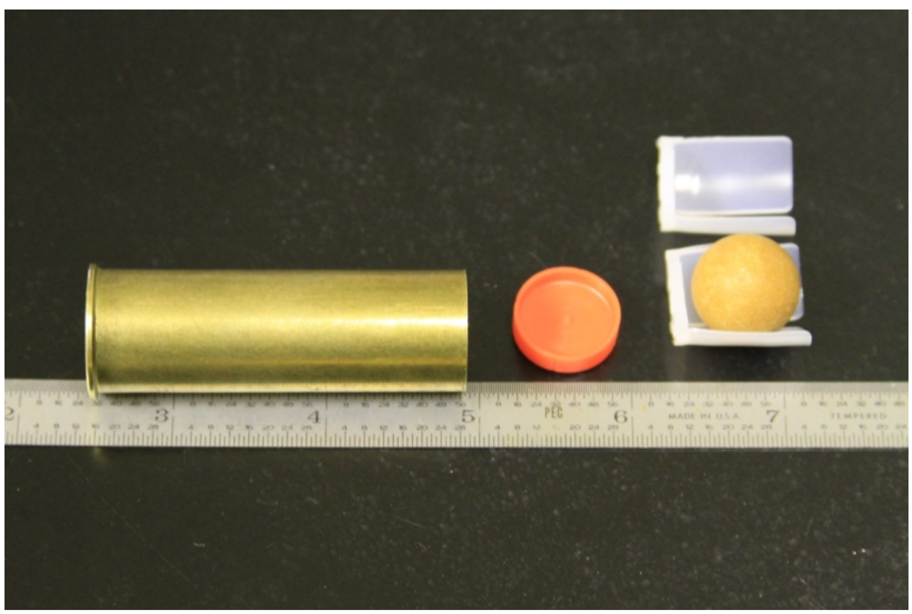
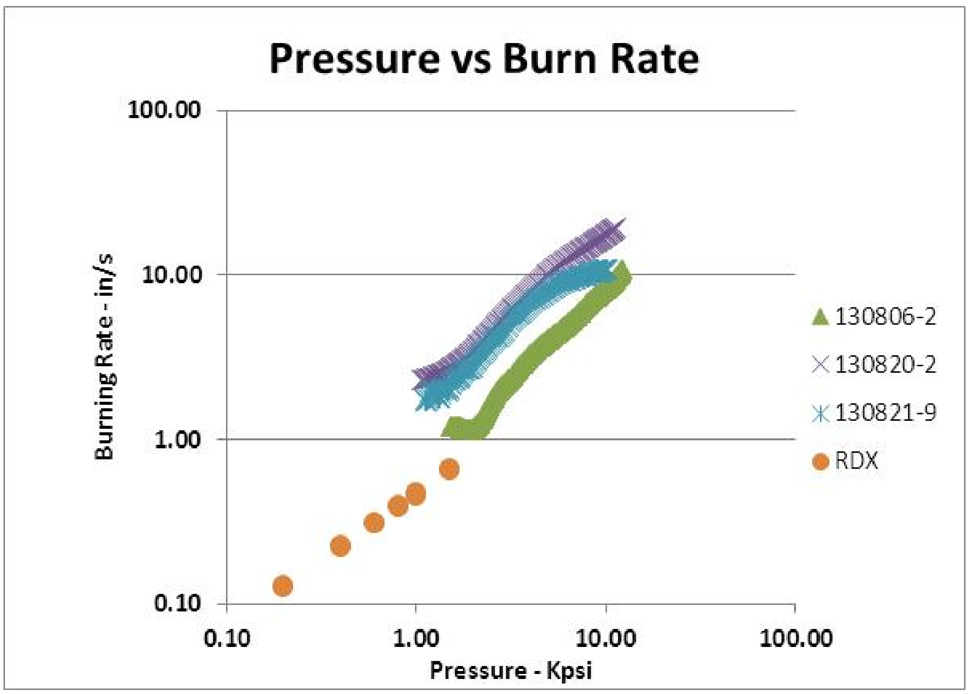


FIGURE 8. 18-mm Arrangement for the Spherical CompB Samples (Inch Scale).

RESULTS

PART I – CYLINDERS

Two undamaged cylinders, Parts 15 and 35 (closed bomb ID 130806-2 and 130820-2), were burned in the closed bomb in order to obtain the linear burning rate of CompB. The burning rate is needed as input for determining the change in burning surface of the damaged explosive. The burning rate versus pressure is plotted in Figure 9. The neat burning rate of RDX is included in the plot for comparison. Closed bomb ID 130821-9, Part 33, was dropped during loading and was reduced as an undamaged cylinder. The problem with the burning rate data is that the undamaged samples are more than two times different in value. This disparity in burning rate will impact the result. No more than 3 percent variation between burning rates is desired.

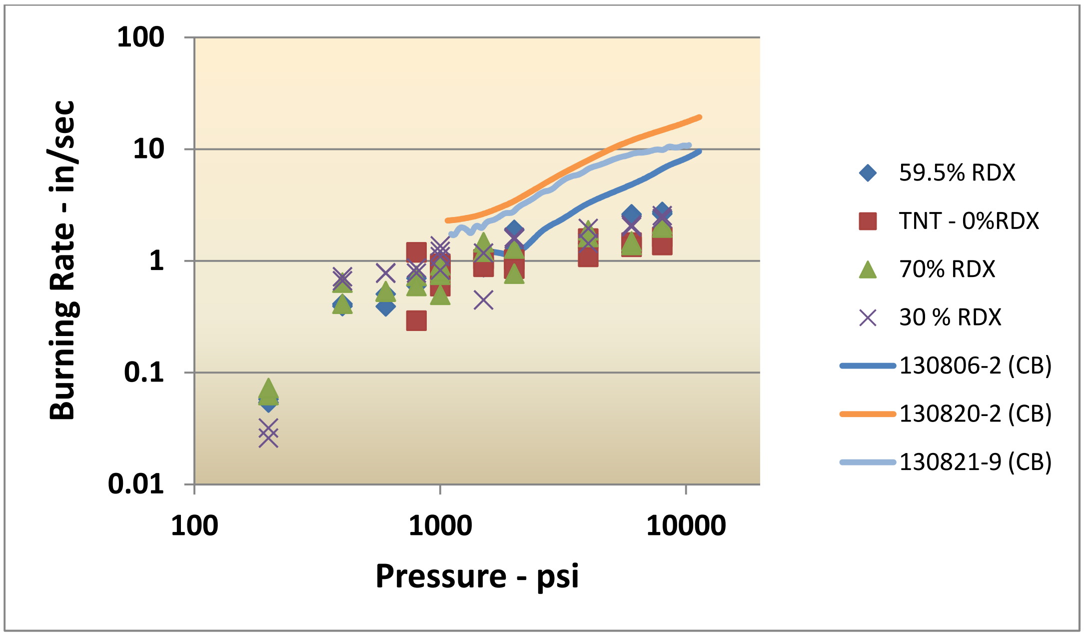


in/s = inches per second, Kpsi = kilo pounds per square inch.

FIGURE 9. CompB Burning Rates Compared to RDX.

LLNL has suggested that the difference in burning rates may be due to sample variation in the formulation due to settling of the RDX filler during the manufacture and cure of the explosive.

A burning rate study was initiated to examine the effects of RDX loading on the CompB burning rate. CompB was formulated at NAWCWD with varying amounts of RDX (0, 30, 59.5, and 70 weight percent). The burning rates, as measured photographically, of these samples are compared to the closed bomb (CB) data from this study in Figure 10. Two observations can be made. First, the increased burning rate exponent (slope) of the closed bomb data is indicative of sample deconsolidation and second, the burning rates of the samples tested photographically, appear to be controlled by TNT rather than RDX.



psi = pounds per square inch.

FIGURE 10. CompB Burning Rates.

Thirty-one cylindrical CompB samples were impact damaged at velocities from 97 to 435 ft/s (29.57 to 132.59 m/s). The percent recovered versus impact velocity is plotted in Figure 11 for the cylindrical CompB samples. The recovered percentage decreased as the impact velocity increased. Tabular data and photographs of the damaged cylinders are summarized in Appendix A.

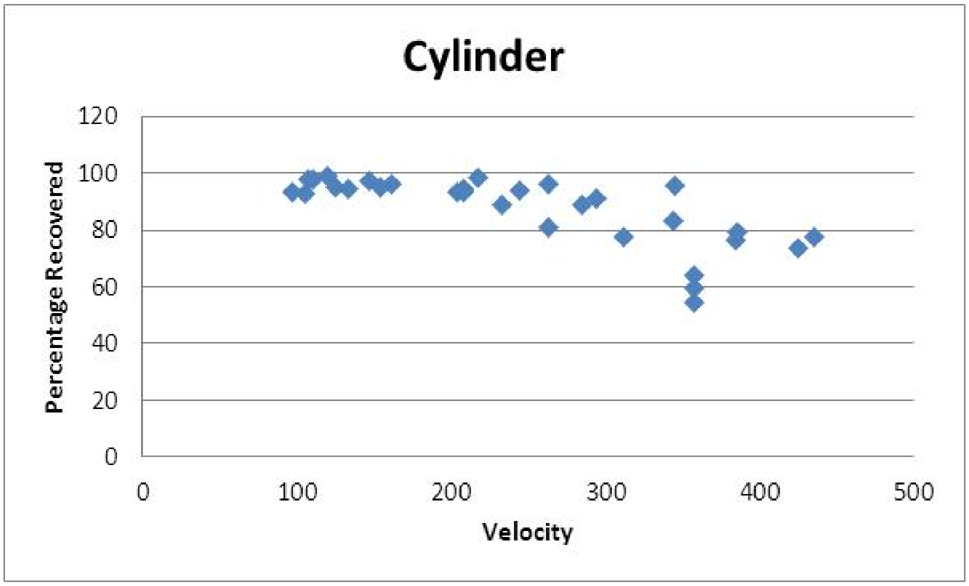


FIGURE 11. Percent Recovered Versus Impact Velocity for Cylindrical Samples.

Cylindrical CompB samples impact damaged at 105 and 385 ft/s can be seen in Figures 12 and 13, respectively. The increased damage with increasing velocity is visible with the decreased large fragments and increased amounts of fine powder.

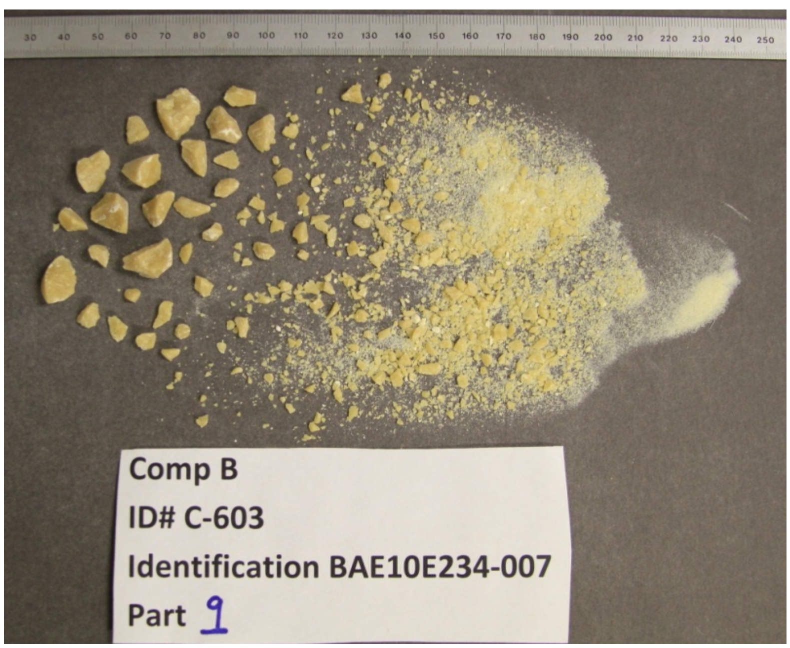


FIGURE 12. Cylindrical CompB Sample Impact Damaged at 105 ft/s.

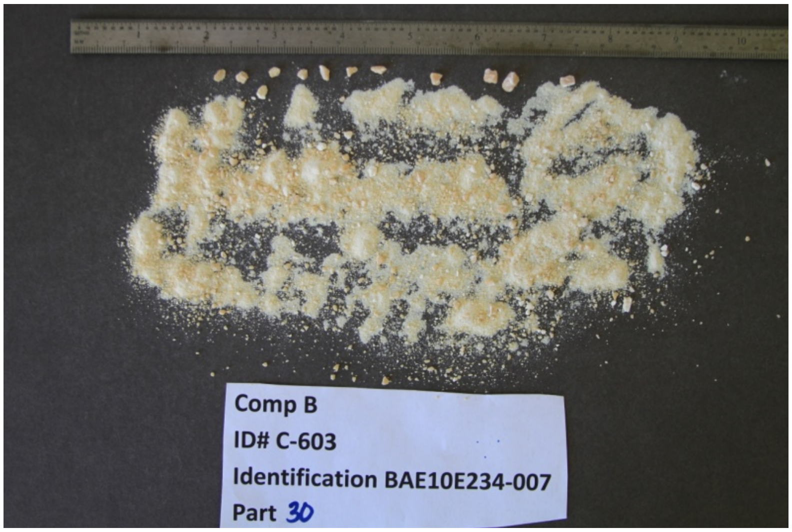


FIGURE 13. Cylindrical CompB Sample Impact Damaged at 385 ft/s.

Figure 14 is an image of the target surface with an impacted sample prior to collection. It can be seen that there has been fine particulates generated by the impact with larger fragments embedded in the fine debris.

FIGURE 14. Impact Target With CompB Cylindrical Sample Debris.

The maximum dp/dt versus impact velocity is plotted for the cylindrical CompB samples in Figure 15. There appears to be at least two distinct populations in these data. The difference in burning rate may be contributing to the data scatter.

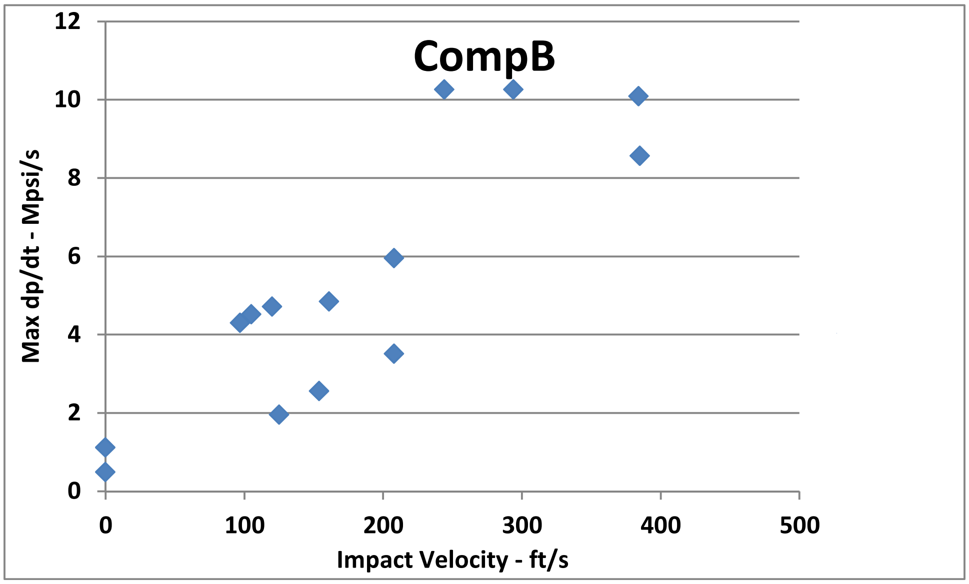


FIGURE 15. Maximum dp/dt Versus Impact Velocity.

Analysis of the damaged samples was performed with both burning rates (high and low) and the maximum change in burning area versus impact velocity is plotted in Figure 16. The increased burn area is about five times greater when the lower burning rate is used rather than the higher values.

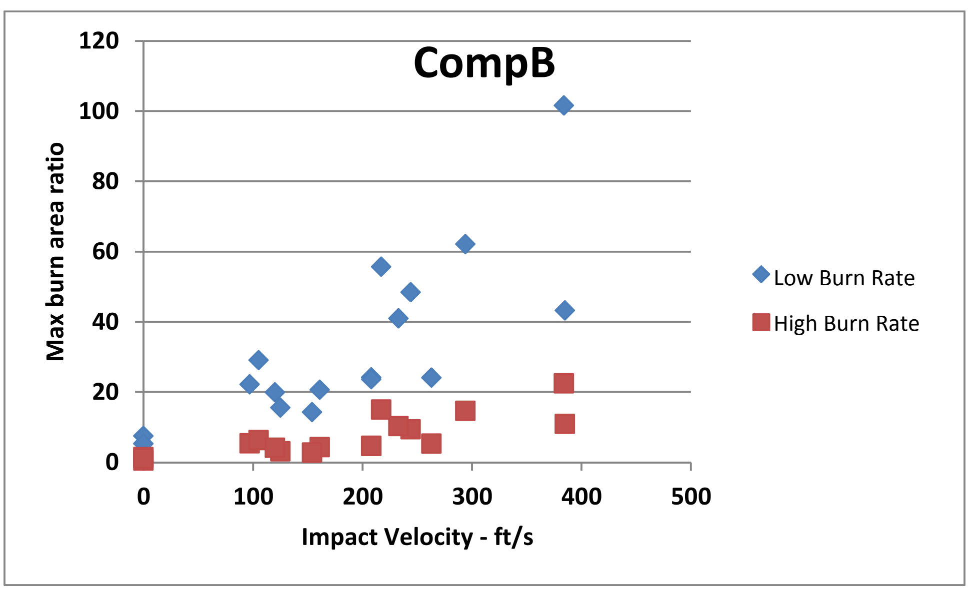


FIGURE 16. Maximum Burn Area Ratio Versus Impact Velocity for CompB Cylinders.

Four additional cylindrical samples were impact damaged and subjected to dry screening. Two samples were damaged at 107 and 110 ft/s and the percent of recovered mass versus particle size data are plotted in Figure 17. The majority of damaged fragments remain larger than 1,000 µm with a small fraction (5 percent) at less than 106 µm. Two samples were damaged at 425 and 435 ft/s and the percent of recovered mass versus particle size data are plotted in Figure 18. The increase in the finest fraction (<106 µm) with a decrease in the coarse (>3360 µm) is evident.

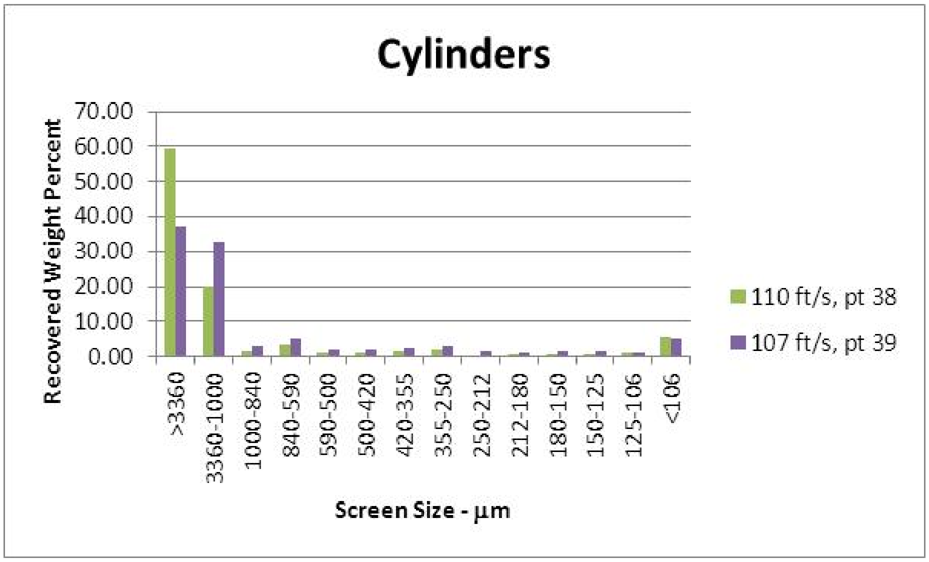


FIGURE 17. Particle Size Distribution of CompB Cylinders Damaged at 107 and 110 ft/s.

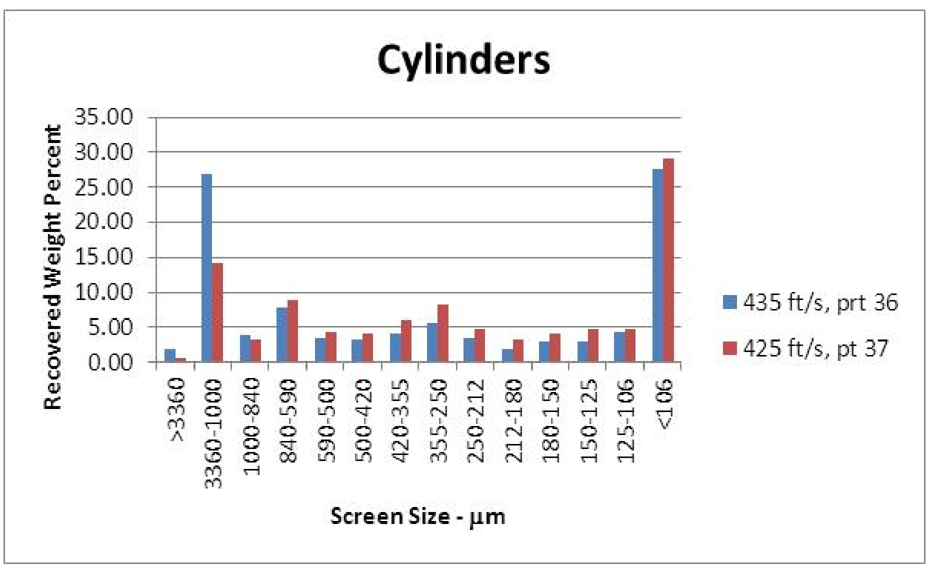


FIGURE 18. Particle Size Distribution of CompB Cylinders Damaged at 425 and 435 ft/s.

PART II – SPHERES

Thirty spherical CompB samples were impact damaged at velocities from 89 to 417 ft/s (27.13 to 127.10 m/s). The percent recovered versus impact velocity is plotted in Figure 19 for the CompB spheres. The recovered percentage decreased as the impact velocity increased. Tabular data and photographs of the damaged samples are summarized in Appendix B.

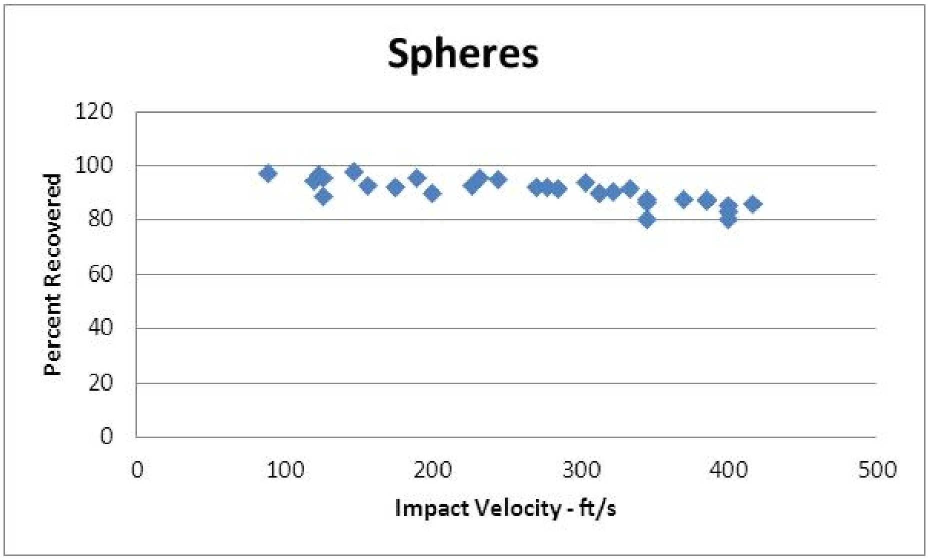


FIGURE 19. Spherical CompB Sample Recovered Versus Impact Velocity.

Screened weights for each of the 27 damaged spherical CompB samples are summarized in Appendix B. Percentages of the individual size fractions were calculated based on the sum of total mass of each fraction. Sample losses due to screening were about 1 percent. Plots of the percent of the individual fractions are given in Figures 20, 24, 26, 28, and 30. The plots have been grouped by increasing velocity for clarity.

The majority of the recovered material was greater than 1,000 µm at impact velocities less than 200 ft/s (61 m/s) (Figure 20). The remaining size fractions were less than 10 percent of the screened total but, the increase in the fine fractions with increasing impact velocity is visible. A photograph of a CompB spherical sample impact damaged at 126 ft/s is shown in Figure 21.

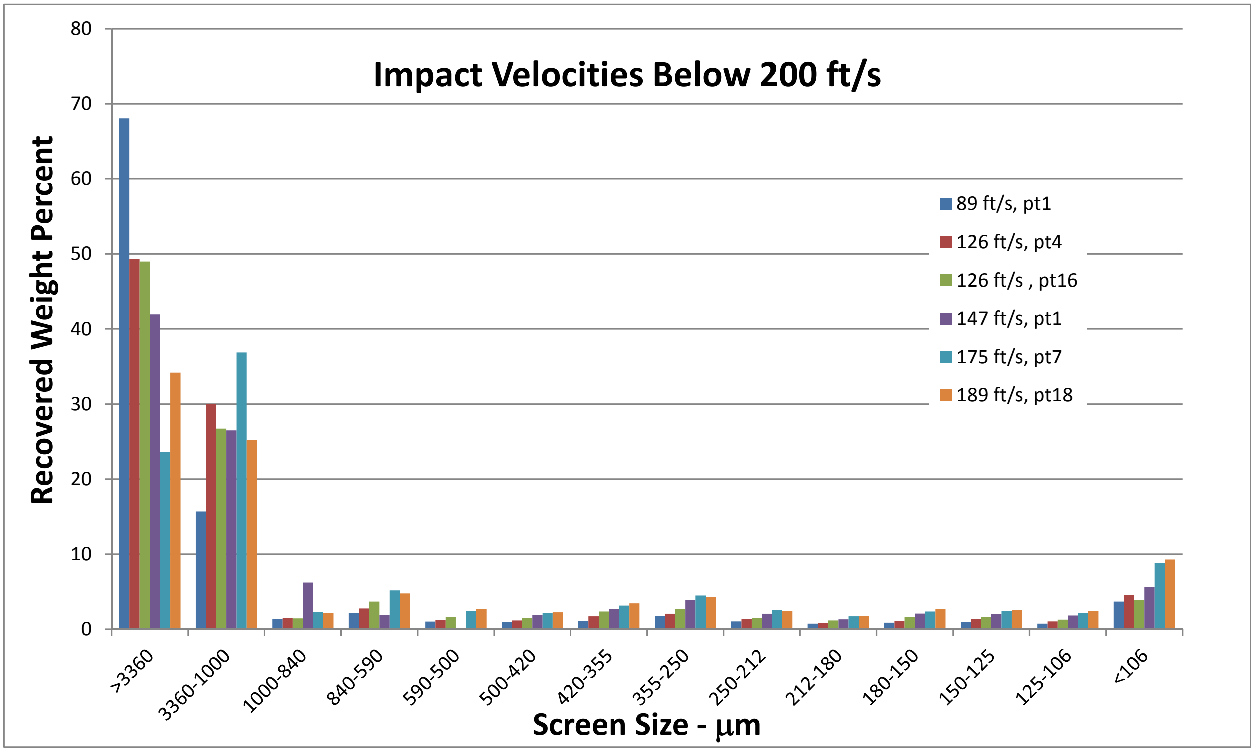


FIGURE 20. Size Fractions for Spherical CompB Samples Impact Damaged at Less Than 200 ft/s.

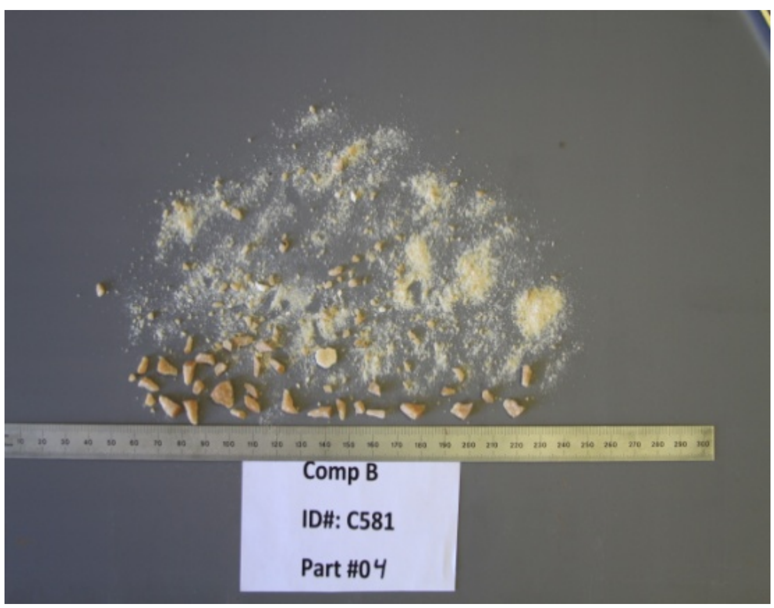


FIGURE 21. Spherical CompB Sample Impact Damaged at 126 ft/s.

Aggregates of re-compacted material as seen in Figure 22, were observed in most of the screened size fractions. If the aggregates did not break up with application of light pressure, they were left undisturbed. It should also be noted, and can be seen in image of Figure 23, that the larger fragments remained coated with fine particles after dry screening. The large aggregates of fine particulates will, in all likelihood, deconsolidate during combustion. The fine coating on the large particles will cause them to burn as “finer” particles as well.

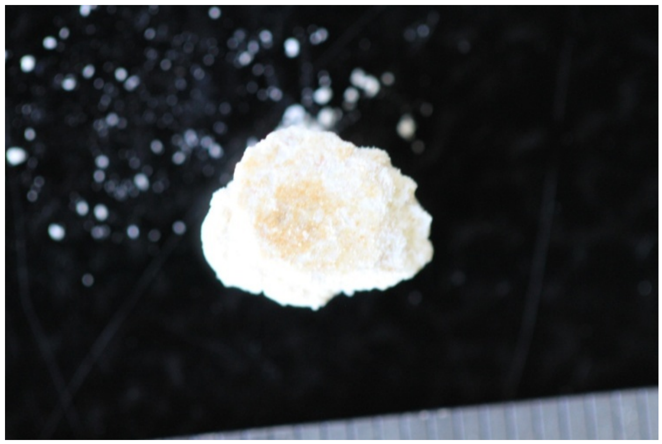


FIGURE 22. Aggregates of Re-compacted Material (mm Scale).

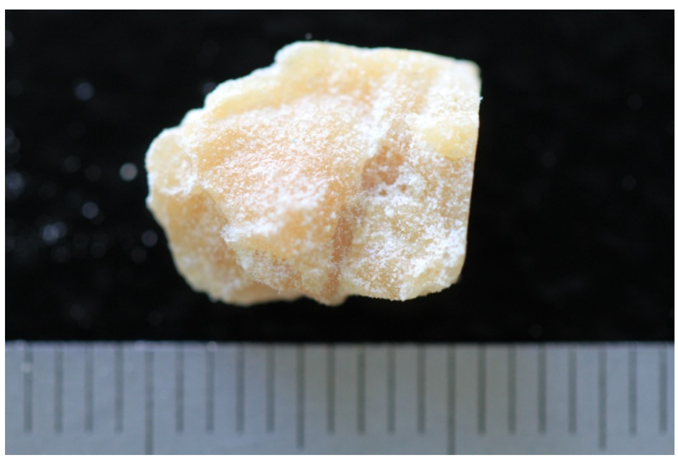


FIGURE 23. Fine CompB Coating Large Fragment (mm Scale).

The size fraction >3,360 µm decreased in the CompB samples impact damaged at velocities between 200 and 285 ft/s (Figure 24) with an increase in the <106 µm fraction. The fraction 1,000 to 3360 µm remained relatively constant. A spherical CompB sample impact damaged at 232 ft/s is shown in Figure 25.

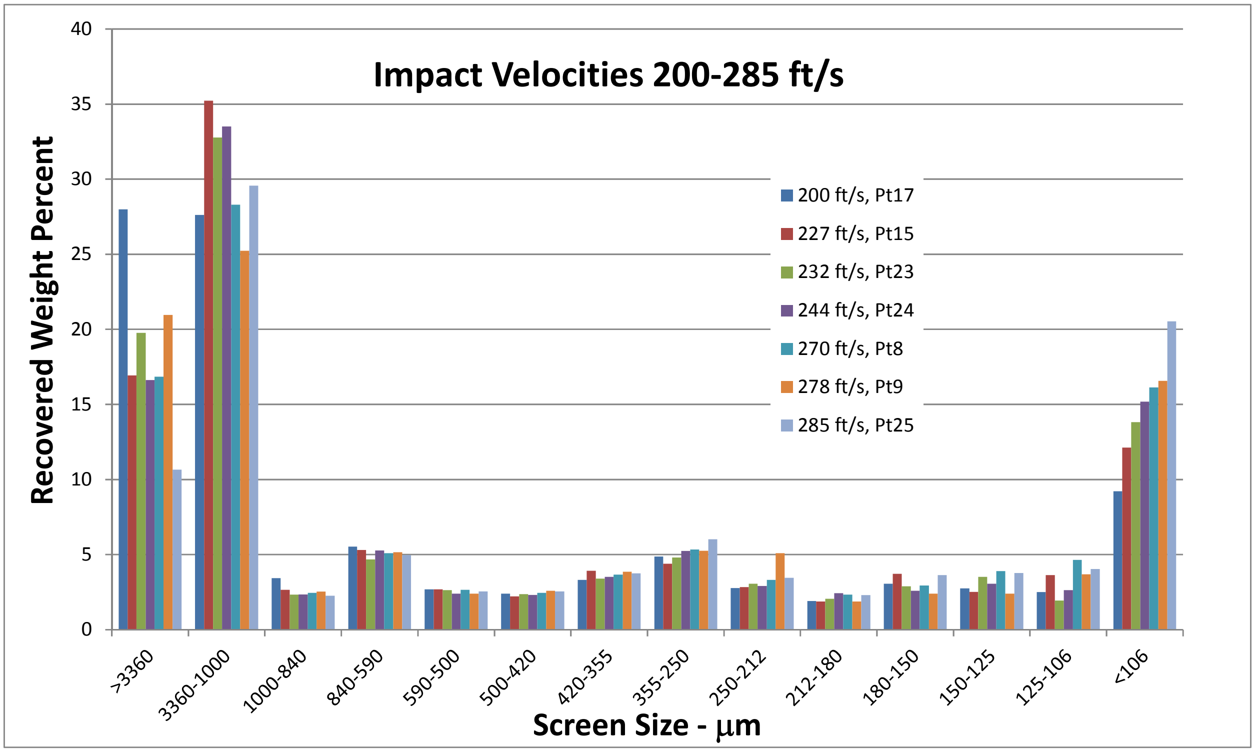


FIGURE 24. Size Fractions for Spherical CompB Samples Impact Damaged Between 200 and 285 ft/s.

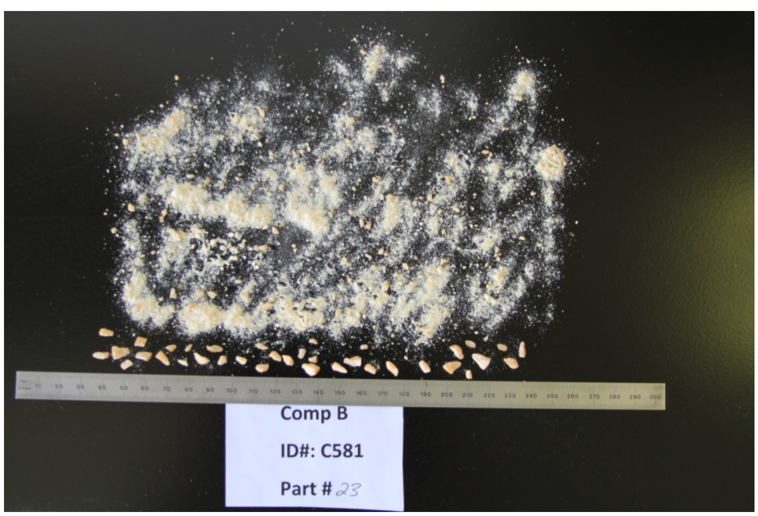


FIGURE 25. Spherical CompB Sample Impact Damaged at 232 ft/s.

The size fractions >3,360 µm and 3,360 to 1,000 µm decreased in the CompB samples impact damaged at velocities between 303 and 345 ft/s (Figure 26) with an increase in the <106 µm fraction. A spherical CompB sample impact damaged at 345 ft/s is shown in Figure 27.

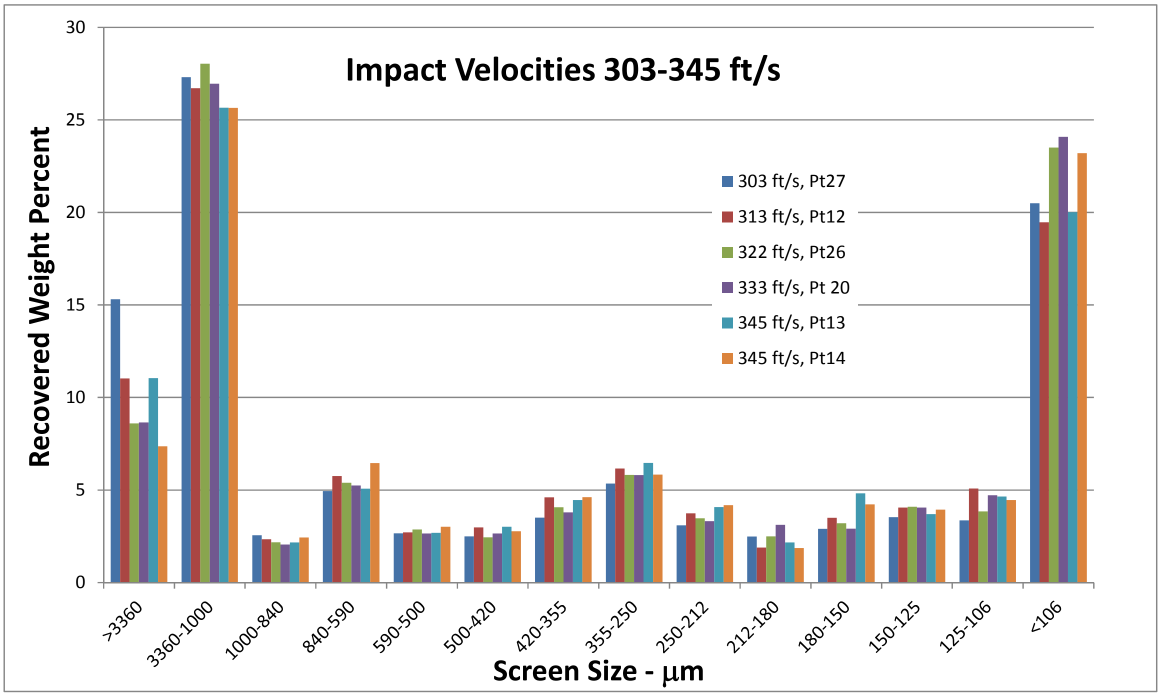


FIGURE 26. Size Fractions for Spherical CompB Samples Impact Damaged Between 303 and 345 ft/s.

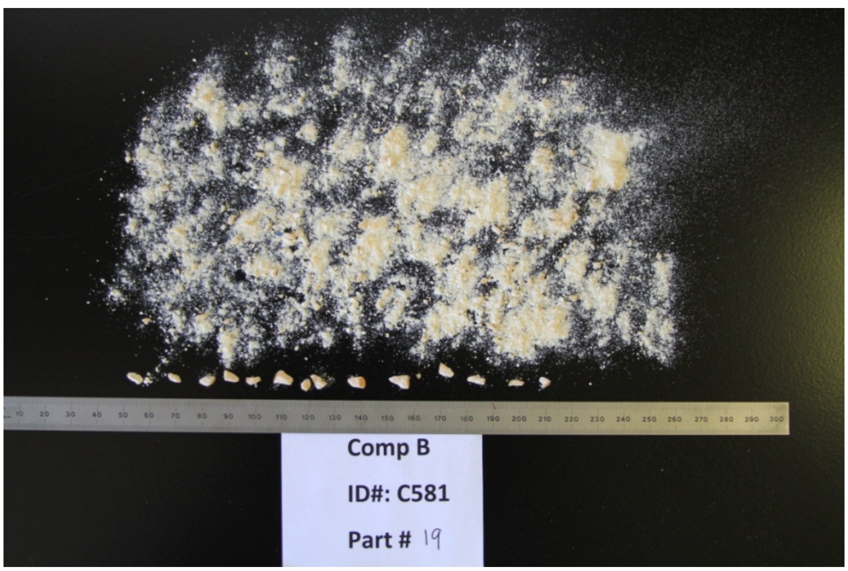


FIGURE 27. Spherical CompB Sample Impact Damaged at 345 ft/s.

The size fraction >3,360 µm decreased to less than 10 weight percent in the CompB samples impact damaged at velocities between 345 and 385 ft/s (Figure 28) with an increase in the <106 µm fraction. The fraction 1,000 to 3,360 µm remained relatively constant. A spherical CompB sample impact damaged at 370 ft/s is shown in Figure 29.

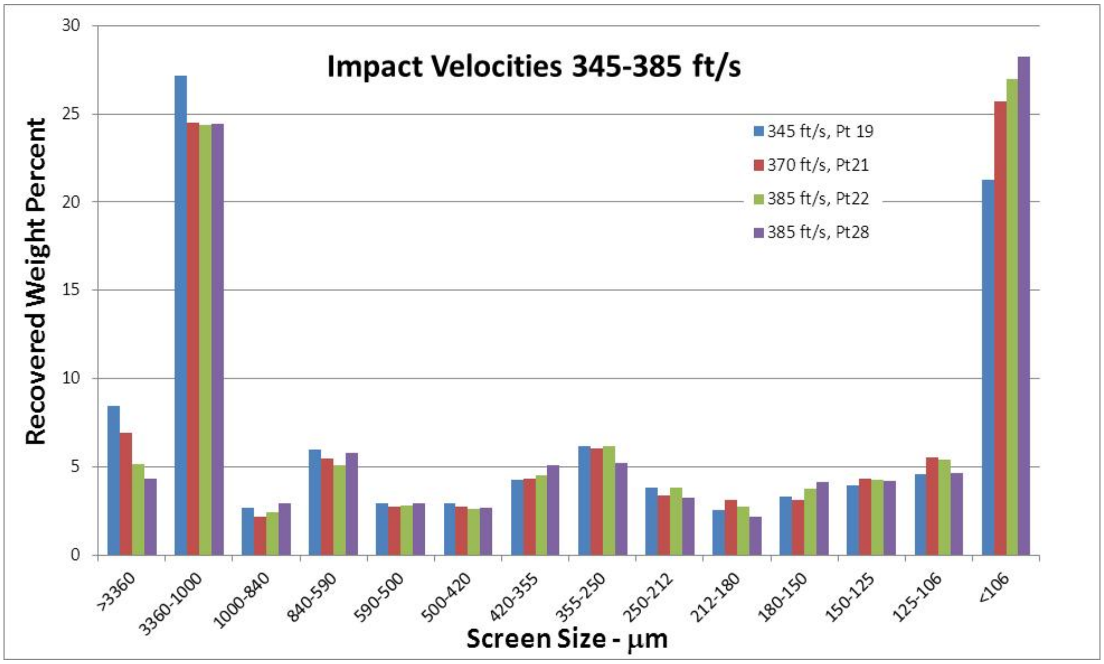


FIGURE 28. Size Fractions for Spherical CompB Samples Impact Damaged Between 345 and 385 ft/s.

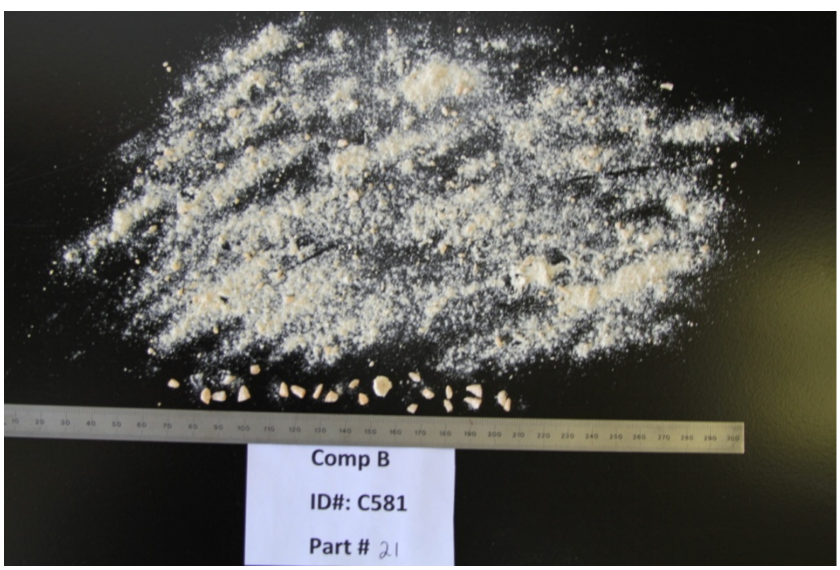


FIGURE 29. Spherical CompB Sample Impact Damaged at 370 ft/s.

The size fraction >3,360 µm again decreased in the CompB samples impact damaged at velocities of 400 and 417 ft/s (Figure 30) with an increase in the <106 µm fraction. The dry screening of Part 10 impact damaged at 400 ft/s was among the first samples subjected to screening and upon examination of the size fractions of that sample, it was obvious that there was not a sufficient level of agitation performed to obtain adequate size separation. Two additional samples were impact damaged at 400 ft/s and the improvement can be seen in Figure 30. It is recommended that the size analysis of Part 10 be disregarded. A photograph of a spherical CompB sample impact damaged at 435 ft/s is given in Figure 31.

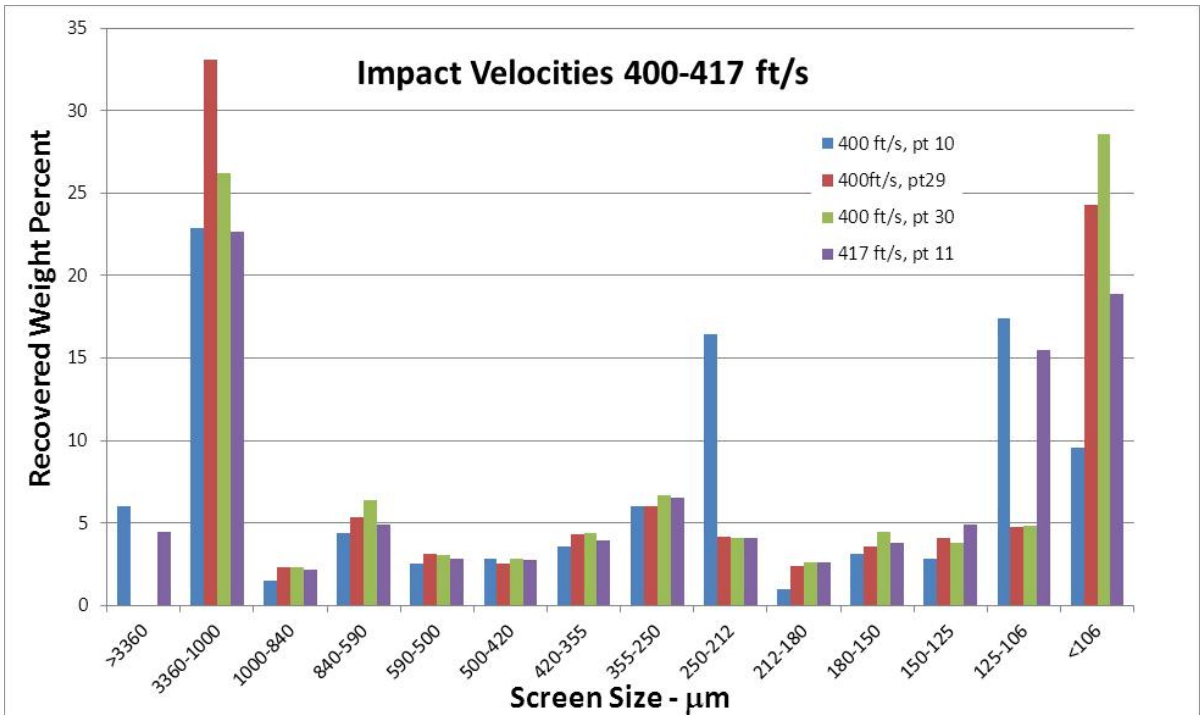


FIGURE 30. Size Fractions for Spherical CompB Samples Impact Damaged at 400 and 417 ft/s.

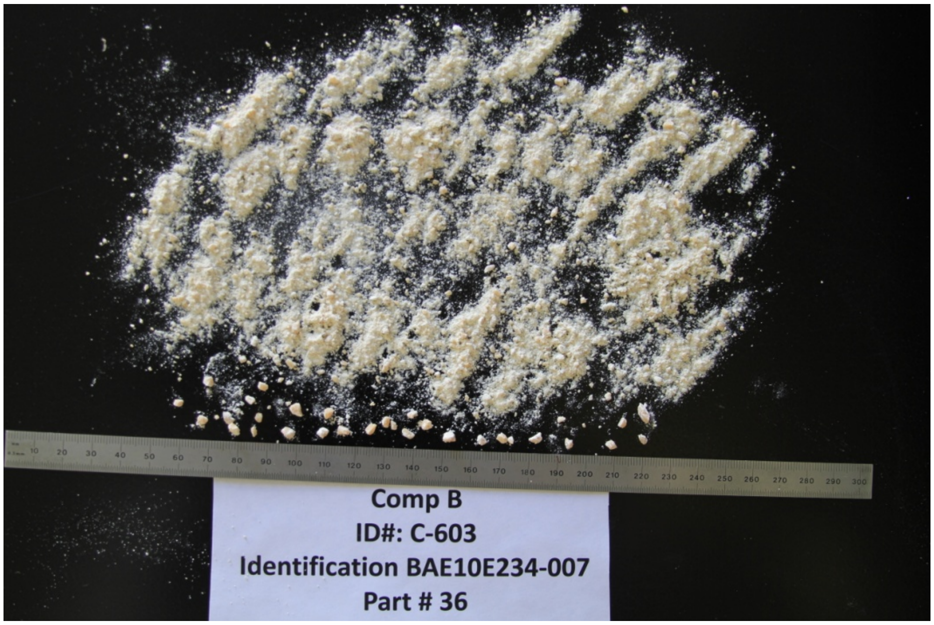


FIGURE 31. Spherical CompB Sample Impact Damaged at 435 ft/s.

Sample reproducibility can be examined for spherical CompB samples impact damaged at 126, 345, 385, and 400 ft/s in Figures 32 through 35, respectively. The Part 10 sample was omitted as recommended previously. The decrease of the fraction >3,360 µm with the increase in the fraction <106 µm is clearly shown. It is interesting to note that the fraction 1,000 to 3,360 µm remains relatively constant over these damage velocities.

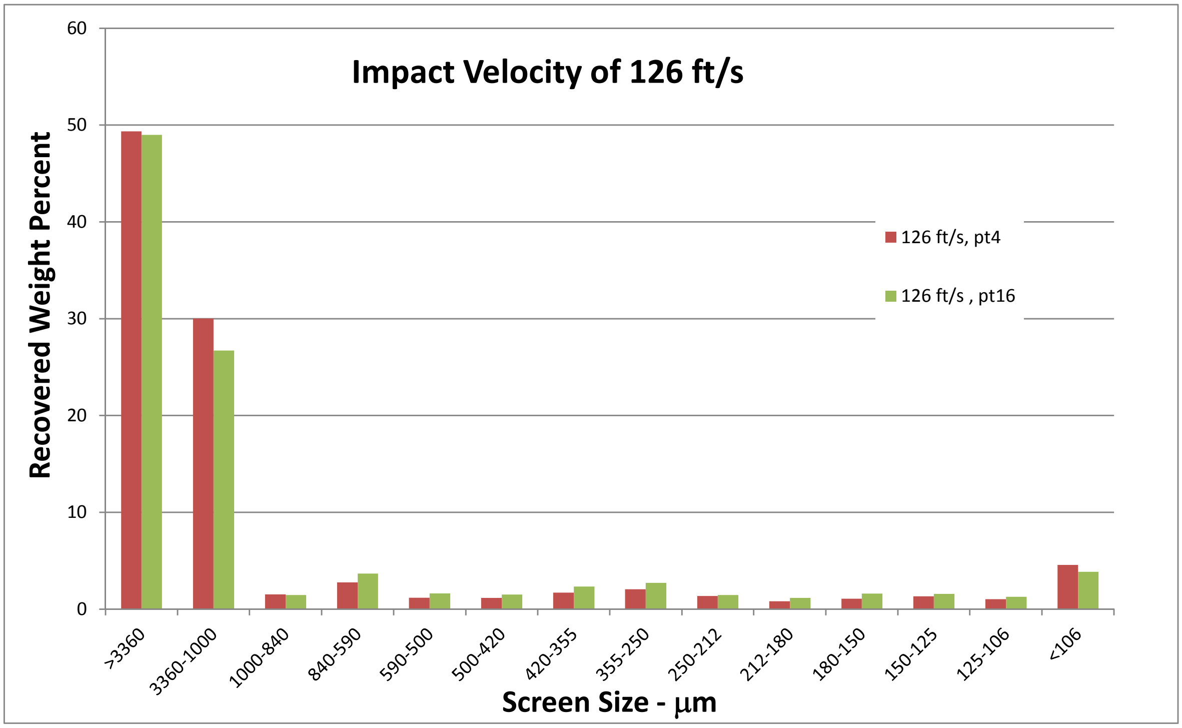


FIGURE 32. Comparison of Spherical CompB Samples Impact Damaged at 126 ft/s.

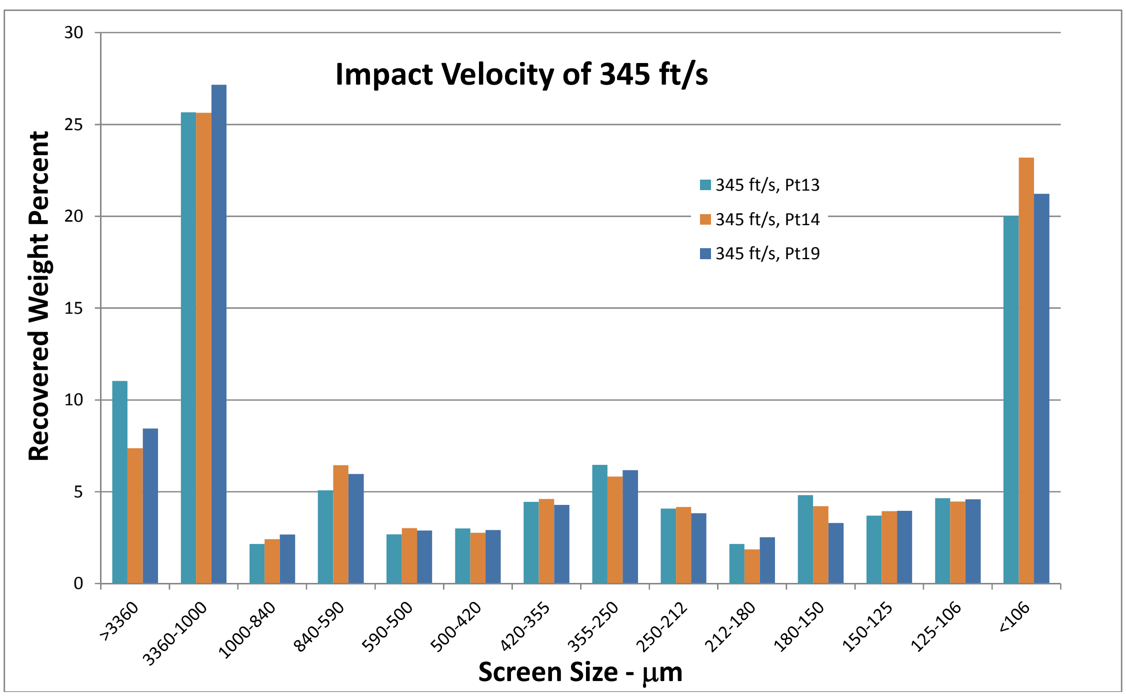


FIGURE 33. Comparison of Spherical CompB Samples Impact Damaged at 345 ft/s.

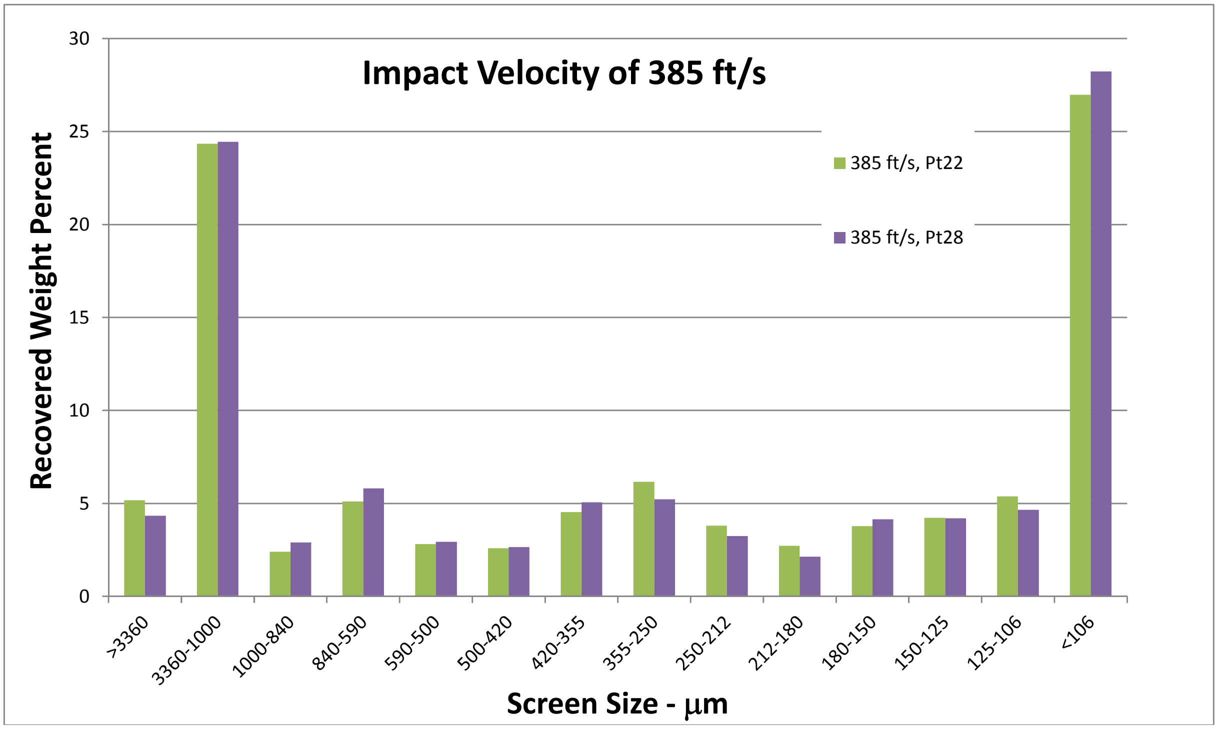


FIGURE 34. Comparison of Spherical CompB Samples Impact Damaged at 385 ft/s.

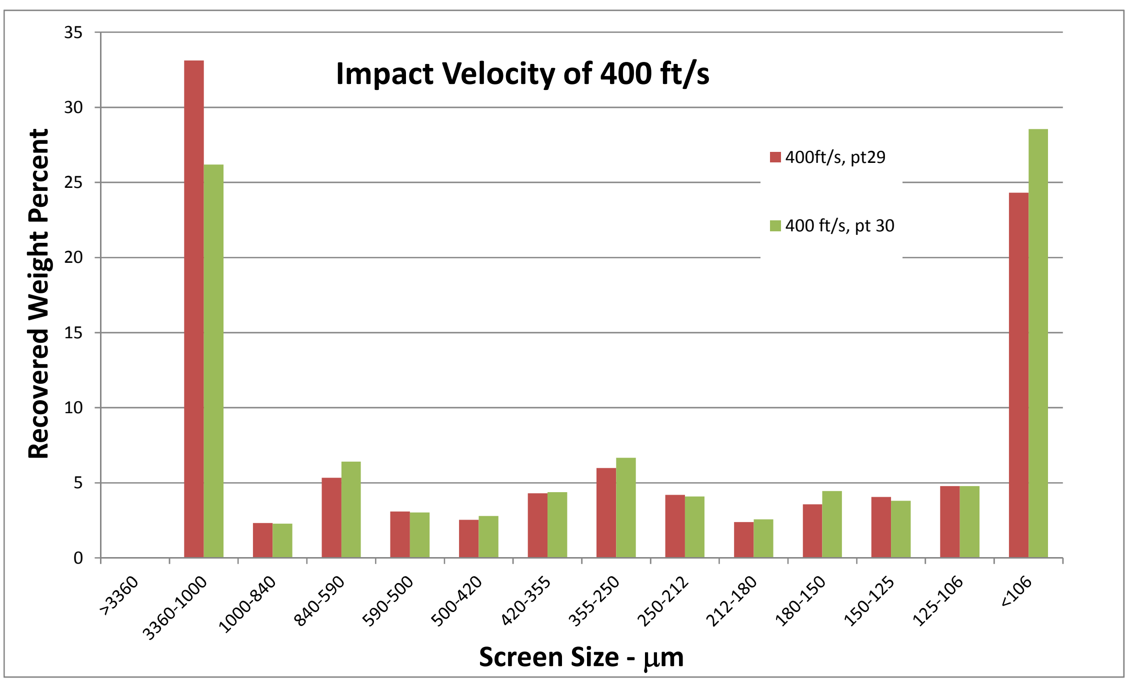


FIGURE 35. Comparison of Spherical CompB Samples Impact Damaged at 400 ft/s.

SUMMARY/CONCLUSIONS

CYLINDRICAL COMPB

Sample nonuniformity was apparent in the undamaged burning rate evaluations and is probably also the cause of the scatter observed in the dp/dt data. A range of damage was estimated based on the two extremes in burning rate; however, the data are suspect without precise burning rate data as input. Screening of the cylindrical samples revealed a bimodal distribution with the majority of the damage falling into either the coarsest (diameter >1,000 μm) or finest (diameter <106 μm) size fractions.

SPHERICAL COMPB

Dry screening of the highly damaged CompB samples required a great deal of agitation to produce an adequate particle separation. A bimodal distribution similar to that of the cylindrical samples was observed in all of the spherical CompB samples. Most of the damage was divided between the greater than 1,000 μm and the less than 106 μm fractions. The finest size fraction increased with increasing impact velocity, while the fraction 3,360 to 1,000 μm remained relatively constant under the conditions of the test.

A re-compaction of the damaged material against the target appears to have occurred in both the cylindrical the spherical samples and it was difficult to completely break the re-compacted clusters. The larger explosive fragments were "dusted" with a light coating of fine material after dry screening was performed.

FURTHER STUDY

The screened CompB size fractions were returned to LLNL for further study. It is recommended that they be submitted to microscopy to ascertain the morphology of the individual particles and that further size analysis be performed on the <106 μm fractions. The variation in CompB burning rates warranted further study. The NAWCWD data will be combined with the larger burning rate database from LLNL to resolve some of the issues related to the observed variations.

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Appendix A

PHOTOGRAPHS AND TABULAR DATA FOR CYLINDERS

(The contents of this appendix are reproduced in facsimile.)

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Damaged Cylindrical CompB

Sample #	Weight, gm	Velocity ft/sec	R. Weight gm	Percent Recovered	
1	9.8843	303.03	3.5421	35.83562	lid left off of catch box - omitted
2	9.9266	243.9	9.3182	93.87101	
3	9.907	147.06	9.6542	97.44827	
4	9.883	125	9.4069	95.18264	
5	9.9441	161.29	9.5348	95.88399	
6	9.8759	153.85	9.4046	95.22778	
7	9.9105	133.33	9.3417	94.26063	
8	9.858	312	7.6217	77.31487	
9	9.9317	105	9.1963	92.59543	
10	9.9508	120	9.8253	98.73879	
11	9.9021	285	8.7828	88.69634	
12	9.9385	344	8.2383	82.89279	
13	9.9187	384	7.6017	76.64008	
16	9.9181	97	9.2347	93.10957	
17	9.8778	204	9.2015	93.15333	
18	9.889	208	9.316	94.20568	
19	9.8841	208	9.2368	93.4511	
20	9.8544	294	8.9632	90.95632	
23	9.8431	208	9.2508	93.98259	
25	9.9135	263	8.0433	81.13482	
26	9.8944	217	9.7079	98.1151	
27	9.9249	233	8.8304	88.97218	
28	9.9426	357	5.4233	54.54609	
29	9.9145	357	5.9116	59.6258	
30	9.9325	385	7.8696	79.23081	
31	9.9086	357	6.3183	63.76582	
32	9.8753	345	9.4608	95.80266	
34	9.8688	263	9.4971	96.23358	
36	9.8692	435	7.6707	77.72363	
37	9.8668	425	7.2743	73.72502	
38	9.8657	110	9.6639	97.95453	
39	9.8063	107	9.5825	97.71779	

130820-2	heat loss option 2	130821-9	heat loss option2		RDX
Pressure	Burn Rate	Pressure	Burn Rate	Pressure	Burn Rate
1.07E+00	2.29E+00	1.11E+00	1.74E+00	0.1	0.074016
1.08E+00	2.30E+00	1.12E+00	1.71E+00	0.1	0.072835
1.10E+00	2.31E+00	1.13E+00	1.70E+00	0.2	0.1311
1.11E+00	2.31E+00	1.14E+00	1.71E+00	0.2	0.12598
1.12E+00	2.32E+00	1.15E+00	1.76E+00	0.4	0.22205
1.14E+00	2.33E+00	1.17E+00	1.82E+00	0.4	0.22598
1.15E+00	2.33E+00	1.18E+00	1.90E+00	0.6	0.31102
1.16E+00	2.34E+00	1.19E+00	1.96E+00	0.6	0.31496
1.18E+00	2.35E+00	1.21E+00	1.99E+00	0.8	0.39606
1.19E+00	2.36E+00	1.23E+00	2.00E+00	0.8	0.39213
1.20E+00	2.37E+00	1.24E+00	1.98E+00	1	0.47992
1.22E+00	2.37E+00	1.26E+00	1.96E+00	1	0.45906
1.23E+00	2.38E+00	1.27E+00	1.92E+00	1.5	0.64803
1.24E+00	2.39E+00	1.28E+00	1.89E+00	1.5	0.66496
1.26E+00	2.40E+00	1.30E+00	1.85E+00		
1.27E+00	2.41E+00	1.31E+00	1.80E+00		
1.28E+00	2.42E+00	1.32E+00	1.78E+00		
1.30E+00	2.43E+00	1.33E+00	1.78E+00		
1.31E+00	2.45E+00	1.34E+00	1.81E+00		
1.33E+00	2.46E+00	1.36E+00	1.87E+00		
1.34E+00	2.47E+00	1.37E+00	1.95E+00		
1.35E+00	2.48E+00	1.39E+00	2.02E+00		
1.37E+00	2.50E+00	1.40E+00	2.06E+00		
1.38E+00	2.51E+00	1.42E+00	2.06E+00		
1.40E+00	2.52E+00	1.43E+00	2.04E+00		
1.41E+00	2.54E+00	1.45E+00	2.00E+00		
1.43E+00	2.56E+00	1.46E+00	1.98E+00		
1.44E+00	2.57E+00	1.48E+00	1.98E+00		
1.46E+00	2.59E+00	1.49E+00	2.01E+00		
1.47E+00	2.61E+00	1.51E+00	2.07E+00		
1.49E+00	2.63E+00	1.52E+00	2.14E+00		
1.50E+00	2.65E+00	1.54E+00	2.20E+00		
1.52E+00	2.67E+00	1.56E+00	2.24E+00		
1.54E+00	2.69E+00	1.57E+00	2.27E+00		
1.55E+00	2.71E+00	1.59E+00	2.29E+00		
1.57E+00	2.73E+00	1.61E+00	2.30E+00		
1.59E+00	2.76E+00	1.63E+00	2.31E+00		
1.60E+00	2.78E+00	1.65E+00	2.33E+00		
1.62E+00	2.81E+00	1.67E+00	2.36E+00		
1.64E+00	2.83E+00	1.69E+00	2.39E+00		
1.66E+00	2.86E+00	1.71E+00	2.43E+00		
1.67E+00	2.89E+00	1.73E+00	2.47E+00		
1.69E+00	2.91E+00	1.75E+00	2.51E+00		
1.71E+00	2.94E+00	1.77E+00	2.56E+00		
1.73E+00	2.97E+00	1.80E+00	2.61E+00		
1.75E+00	3.00E+00	1.82E+00	2.65E+00		
1.77E+00	3.03E+00	1.84E+00	2.67E+00		
1.79E+00	3.07E+00	1.87E+00	2.69E+00		

130820-2	heat loss option 2	130821-9	heat loss option2		RDX
Pressure	Burn Rate	Pressure	Burn Rate	Pressure	Burn Rate
1.81E+00	3.10E+00	1.89E+00	2.69E+00		
1.83E+00	3.13E+00	1.92E+00	2.68E+00		
1.85E+00	3.17E+00	1.94E+00	2.69E+00		
1.87E+00	3.20E+00	1.97E+00	2.72E+00		
1.90E+00	3.24E+00	1.99E+00	2.77E+00		
1.92E+00	3.28E+00	2.02E+00	2.85E+00		
1.94E+00	3.32E+00	2.04E+00	2.93E+00		
1.96E+00	3.36E+00	2.07E+00	3.01E+00		
1.99E+00	3.41E+00	2.10E+00	3.09E+00		
2.01E+00	3.46E+00	2.13E+00	3.15E+00		
2.04E+00	3.51E+00	2.16E+00	3.21E+00		
2.06E+00	3.56E+00	2.20E+00	3.26E+00		
2.09E+00	3.62E+00	2.23E+00	3.32E+00		
2.12E+00	3.67E+00	2.26E+00	3.38E+00		
2.14E+00	3.73E+00	2.30E+00	3.44E+00		
2.17E+00	3.79E+00	2.33E+00	3.51E+00		
2.20E+00	3.86E+00	2.37E+00	3.58E+00		
2.23E+00	3.92E+00	2.41E+00	3.66E+00		
2.26E+00	3.99E+00	2.44E+00	3.76E+00		
2.29E+00	4.06E+00	2.48E+00	3.85E+00		
2.32E+00	4.14E+00	2.53E+00	3.96E+00		
2.35E+00	4.21E+00	2.57E+00	4.05E+00		
2.39E+00	4.29E+00	2.61E+00	4.13E+00		
2.42E+00	4.37E+00	2.66E+00	4.18E+00		
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2.61E+00	4.81E+00	2.89E+00	4.50E+00		
2.65E+00	4.91E+00	2.94E+00	4.64E+00		
2.69E+00	5.00E+00	3.00E+00	4.81E+00		
2.73E+00	5.11E+00	3.05E+00	4.97E+00		
2.78E+00	5.21E+00	3.11E+00	5.12E+00		
2.82E+00	5.32E+00	3.17E+00	5.26E+00		
2.87E+00	5.42E+00	3.23E+00	5.40E+00		
2.91E+00	5.54E+00	3.29E+00	5.52E+00		
2.96E+00	5.65E+00	3.35E+00	5.63E+00		
3.01E+00	5.76E+00	3.42E+00	5.71E+00		
3.06E+00	5.88E+00	3.49E+00	5.78E+00		
3.11E+00	6.00E+00	3.55E+00	5.83E+00		
3.17E+00	6.12E+00	3.62E+00	5.89E+00		
3.22E+00	6.24E+00	3.69E+00	5.98E+00		
3.28E+00	6.37E+00	3.76E+00	6.10E+00		
3.33E+00	6.50E+00	3.83E+00	6.26E+00		
3.39E+00	6.63E+00	3.90E+00	6.44E+00		
3.45E+00	6.76E+00	3.98E+00	6.60E+00		
3.51E+00	6.90E+00	4.05E+00	6.75E+00		
3.57E+00	7.03E+00	4.13E+00	6.88E+00		

130820-2	heat loss option 2	130821-9	heat loss option2		RDX
Pressure	Burn Rate	Pressure	Burn Rate	Pressure	Burn Rate
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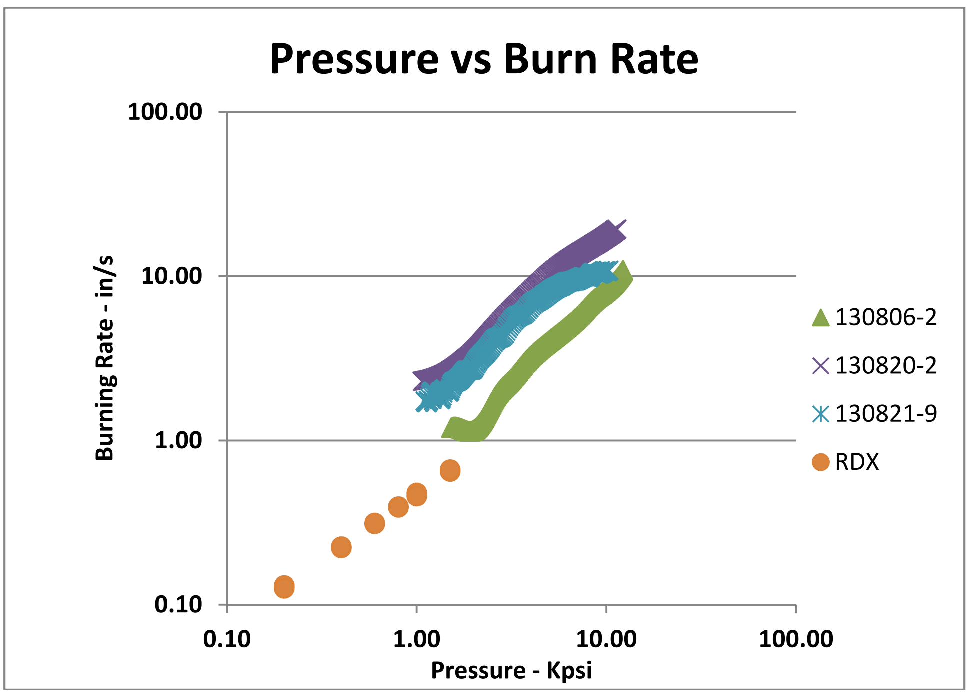
3.70E+00	7.32E+00	4.29E+00	7.06E+00		
3.77E+00	7.46E+00	4.38E+00	7.15E+00		
3.84E+00	7.61E+00	4.46E+00	7.25E+00		
3.91E+00	7.76E+00	4.54E+00	7.36E+00		
3.98E+00	7.92E+00	4.63E+00	7.48E+00		
4.05E+00	8.07E+00	4.71E+00	7.60E+00		
4.12E+00	8.23E+00	4.80E+00	7.72E+00		
4.20E+00	8.40E+00	4.89E+00	7.85E+00		
4.27E+00	8.57E+00	4.98E+00	7.97E+00		
4.35E+00	8.74E+00	5.07E+00	8.10E+00		
4.43E+00	8.91E+00	5.16E+00	8.22E+00		
4.51E+00	9.09E+00	5.26E+00	8.33E+00		
4.59E+00	9.27E+00	5.35E+00	8.43E+00		
4.68E+00	9.45E+00	5.44E+00	8.52E+00		
4.76E+00	9.64E+00	5.54E+00	8.59E+00		
4.85E+00	9.83E+00	5.63E+00	8.67E+00		
4.94E+00	1.00E+01	5.73E+00	8.75E+00		
5.03E+00	1.02E+01	5.83E+00	8.84E+00		
5.12E+00	1.04E+01	5.92E+00	8.94E+00		
5.22E+00	1.06E+01	6.02E+00	9.05E+00		
5.31E+00	1.08E+01	6.12E+00	9.14E+00		
5.41E+00	1.09E+01	6.22E+00	9.22E+00		
5.50E+00	1.11E+01	6.32E+00	9.27E+00		
5.60E+00	1.13E+01	6.41E+00	9.29E+00		
5.70E+00	1.15E+01	6.51E+00	9.30E+00		
5.80E+00	1.16E+01	6.61E+00	9.32E+00		
5.90E+00	1.18E+01	6.71E+00	9.35E+00		
6.01E+00	1.20E+01	6.80E+00	9.39E+00		
6.11E+00	1.21E+01	6.90E+00	9.44E+00		
6.21E+00	1.23E+01	6.99E+00	9.50E+00		
6.32E+00	1.25E+01	7.09E+00	9.57E+00		
6.42E+00	1.26E+01	7.19E+00	9.64E+00		
6.53E+00	1.28E+01	7.28E+00	9.72E+00		
6.64E+00	1.30E+01	7.38E+00	9.80E+00		
6.75E+00	1.31E+01	7.48E+00	9.88E+00		
6.86E+00	1.33E+01	7.57E+00	9.92E+00		
6.96E+00	1.34E+01	7.67E+00	9.93E+00		
7.07E+00	1.36E+01	7.76E+00	9.91E+00		
7.18E+00	1.37E+01	7.86E+00	9.86E+00		
7.30E+00	1.39E+01	7.95E+00	9.84E+00		
7.41E+00	1.40E+01	8.04E+00	9.86E+00		
7.52E+00	1.42E+01	8.13E+00	9.94E+00		
7.63E+00	1.43E+01	8.22E+00	1.01E+01		
7.74E+00	1.45E+01	8.32E+00	1.03E+01		
7.85E+00	1.46E+01	8.41E+00	1.04E+01		
7.97E+00	1.48E+01	8.50E+00	1.05E+01		
8.08E+00	1.49E+01	8.60E+00	1.06E+01		

130820-2	heat loss option 2	130821-9	heat loss option2		RDX
Pressure	Burn Rate	Pressure	Burn Rate	Pressure	Burn Rate
8.19E+00	1.51E+01	8.69E+00	1.05E+01		
8.30E+00	1.52E+01	8.78E+00	1.05E+01		
8.41E+00	1.54E+01	8.87E+00	1.04E+01		
8.53E+00	1.55E+01	8.96E+00	1.04E+01		
8.64E+00	1.56E+01	9.05E+00	1.04E+01		
8.75E+00	1.58E+01	9.13E+00	1.04E+01		
8.86E+00	1.59E+01	9.22E+00	1.04E+01		
8.97E+00	1.61E+01	9.30E+00	1.04E+01		
9.09E+00	1.62E+01	9.39E+00	1.05E+01		
9.20E+00	1.64E+01	9.47E+00	1.05E+01		
9.31E+00	1.65E+01	9.56E+00	1.06E+01		
9.42E+00	1.67E+01	9.64E+00	1.07E+01		
9.53E+00	1.68E+01	9.72E+00	1.08E+01		
9.64E+00	1.70E+01	9.81E+00	1.08E+01		
9.75E+00	1.71E+01	9.89E+00	1.08E+01		
9.86E+00	1.72E+01	9.97E+00	1.07E+01		
9.97E+00	1.74E+01	1.00E+01	1.07E+01		
1.01E+01	1.75E+01	1.01E+01	1.07E+01		
1.02E+01	1.77E+01	1.02E+01	1.08E+01		
1.03E+01	1.78E+01	1.03E+01	1.09E+01		
1.04E+01	1.80E+01	1.04E+01	1.10E+01		
1.05E+01	1.81E+01	1.04E+01	1.11E+01		
1.06E+01	1.83E+01	1.05E+01	1.12E+01		
1.07E+01	1.85E+01	1.06E+01	1.12E+01		
1.08E+01	1.86E+01	1.07E+01	1.12E+01		
1.09E+01	1.88E+01	1.07E+01	1.12E+01		
1.10E+01	1.89E+01	1.08E+01	1.12E+01		
1.11E+01	1.91E+01	1.09E+01	1.12E+01		
1.12E+01	1.92E+01	1.10E+01	1.12E+01		
1.13E+01	1.94E+01	1.10E+01	1.13E+01		
1.14E+01	1.95E+01	1.11E+01	1.15E+01		
1.15E+01	1.97E+01	1.12E+01	1.16E+01		
1.16E+01	1.98E+01	1.13E+01	1.17E+01		
1.17E+01	2.00E+01	1.13E+01	1.18E+01		
1.18E+01	2.01E+01	1.14E+01	1.18E+01		
1.19E+01	2.03E+01	1.15E+01	1.19E+01		
1.20E+01	2.04E+01	1.15E+01	1.19E+01		
1.21E+01	2.05E+01	1.16E+01	1.19E+01		
1.22E+01	2.07E+01	1.17E+01	1.19E+01		
1.23E+01	2.08E+01	1.17E+01	1.19E+01		
1.24E+01	2.10E+01	1.18E+01	1.19E+01		
1.24E+01	2.11E+01	1.19E+01	1.19E+01		
1.25E+01	2.12E+01	1.19E+01	1.21E+01		
1.26E+01	2.14E+01	1.20E+01	1.23E+01		
1.27E+01	2.15E+01	1.21E+01	1.26E+01		
1.28E+01	2.16E+01	1.21E+01	1.28E+01		
1.29E+01	2.17E+01	1.22E+01	1.30E+01		
1.29E+01	2.19E+01	1.23E+01	1.31E+01		

130820-2	heat loss option 2	130821-9	heat loss option2		RDX
Pressure	Burn Rate	Pressure	Burn Rate	Pressure	Burn Rate
1.30E+01	2.20E+01	1.23E+01	1.31E+01		
1.31E+01	2.21E+01	1.24E+01	1.31E+01		
1.32E+01	2.22E+01	1.24E+01	1.31E+01		
1.32E+01	2.23E+01	1.25E+01	1.31E+01		
1.33E+01	2.24E+01	1.26E+01	1.32E+01		
1.34E+01	2.24E+01	1.26E+01	1.32E+01		
1.34E+01	2.25E+01	1.27E+01	1.34E+01		
1.35E+01	2.26E+01	1.27E+01	1.35E+01		
1.36E+01	2.26E+01	1.28E+01	1.36E+01		
1.36E+01	2.27E+01	1.29E+01	1.37E+01		
1.37E+01	2.27E+01	1.29E+01	1.38E+01		
1.38E+01	2.28E+01	1.30E+01	1.39E+01		
1.38E+01	2.28E+01	1.30E+01	1.40E+01		
1.39E+01	2.29E+01	1.31E+01	1.40E+01		
1.39E+01	2.29E+01	1.31E+01	1.39E+01		
1.40E+01	2.30E+01	1.32E+01	1.38E+01		
1.40E+01	2.31E+01	1.32E+01	1.37E+01		
1.41E+01	2.32E+01	1.33E+01	1.37E+01		
1.41E+01	2.33E+01	1.33E+01	1.37E+01		
1.42E+01	2.34E+01	1.34E+01	1.39E+01		
1.42E+01	2.35E+01	1.34E+01	1.42E+01		
1.42E+01	2.36E+01	1.35E+01	1.45E+01		
1.43E+01	2.38E+01	1.35E+01	1.47E+01		
1.43E+01	2.40E+01	1.35E+01	1.49E+01		
1.44E+01	2.42E+01	1.36E+01	1.51E+01		
1.44E+01	2.44E+01	1.36E+01	1.52E+01		
1.44E+01	2.46E+01	1.37E+01	1.53E+01		
1.45E+01	2.49E+01	1.37E+01	1.53E+01		
1.45E+01	2.52E+01	1.38E+01	1.53E+01		
1.45E+01	2.55E+01	1.38E+01	1.53E+01		
1.45E+01	2.59E+01	1.38E+01	1.53E+01		
1.46E+01	2.63E+01	1.39E+01	1.54E+01		
1.46E+01	2.67E+01	1.39E+01	1.55E+01		
1.46E+01	2.73E+01	1.39E+01	1.57E+01		
1.46E+01	2.78E+01	1.40E+01	1.60E+01		
1.47E+01	2.85E+01	1.40E+01	1.64E+01		
1.47E+01	2.93E+01	1.40E+01	1.66E+01		
1.47E+01	3.01E+01	1.41E+01	1.68E+01		
1.47E+01	3.11E+01	1.41E+01	1.69E+01		
1.48E+01	3.23E+01	1.41E+01	1.68E+01		
1.48E+01	3.37E+01	1.42E+01	1.68E+01		
1.48E+01	3.53E+01	1.42E+01	1.69E+01		
1.48E+01	3.73E+01	1.42E+01	1.72E+01		
1.48E+01	3.97E+01	1.42E+01	1.75E+01		
1.48E+01	4.27E+01	1.43E+01	1.80E+01		
1.48E+01	4.66E+01	1.43E+01	1.86E+01		
1.49E+01	5.19E+01	1.43E+01	1.92E+01		
1.49E+01	5.96E+01	1.43E+01	1.98E+01		

130820-2	heat loss option 2	130821-9	heat loss option2		RDX
Pressure	Burn Rate	Pressure	Burn Rate	Pressure	Burn Rate
1.49E+01	7.19E+01	1.44E+01	2.04E+01		
1.49E+01	9.58E+01	1.44E+01	2.11E+01		
1.49E+01	1.75E+02	1.44E+01	2.17E+01		
1.49E+01	7.50E+02	1.44E+01	2.24E+01		
0.00E+00	0.00E+00	1.45E+01	2.30E+01		
		1.45E+01	2.36E+01		
		1.45E+01	2.43E+01		
		1.45E+01	2.52E+01		
		1.45E+01	2.65E+01		
		1.46E+01	2.82E+01		
		1.46E+01	3.05E+01		
		1.46E+01	3.33E+01		
		1.46E+01	3.65E+01		
		1.46E+01	4.02E+01		
		1.46E+01	4.48E+01		
		1.47E+01	5.09E+01		
		1.47E+01	6.08E+01		
		1.47E+01	8.19E+01		
		1.47E+01	1.68E+02		
		1.47E+01	9.27E+02		
		0.00E+00	0.00E+00		

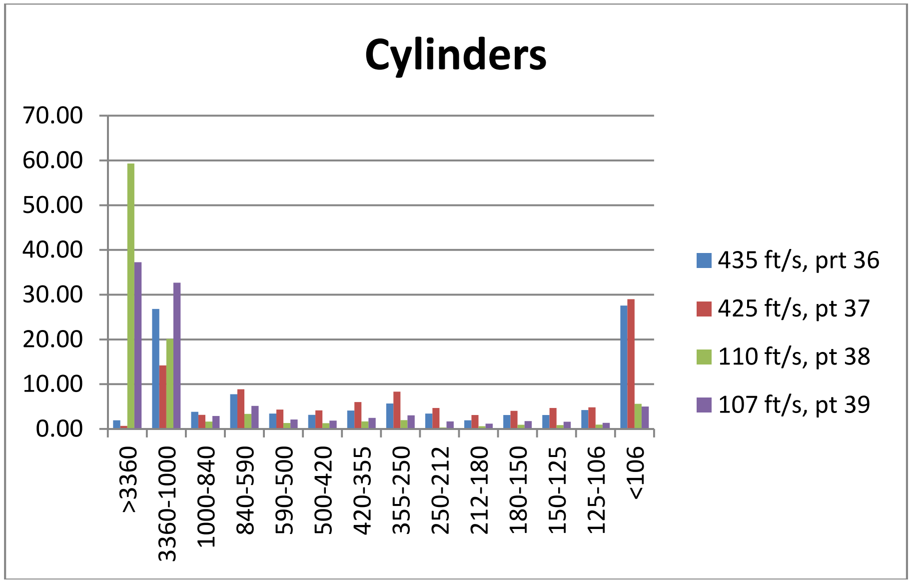


CB run	CYLINDER	VELOCITY	MAX DP/DT	Max areaLbr	Max area Hbr	Initial S - in^2	Initial V - in^3	Lbr S/V - in^{-1}	Hbr S/V - in^{-1}	µm	LbrEquiv sphere µm	HbrEquiv sphere
130806-2	15	0	0.483318		2.17	0.4712	2.7458	0.348	17.12179885	3.717876322	8900.933911	40991.14301
130820-2	35	0	1.105882		7.4456	1.456	2.72938	0.34638	58.66929883	11.47288319	2597.610727	13283.49618
130821-9	33	0	0.788309	dropped	5.264	1.0735	2.72607	0.34576	41.50287043	8.463778763	3672.035173	18006.14173
130806-3	16	97	4.29316		22.173	5.33482	2.53737	0.32153	174.9793332	42.09999758	870.9599997	3619.952702
130806-5	9	105	4.510921		29.02	6.232	2.62305	0.33255	228.9006495	49.15605954	665.7910334	3100.329876
130820-7	10	120	4.705125		19.8635	4.1294	2.65539	0.33665	156.6770808	32.5714168	972.7012986	4678.949059
130820-4	4	125	1.947066		15.49	3.105	2.58827	0.32798	122.2400826	24.50325736	1246.726906	6219.581248
130820-6	6	154	2.549661		14.259	2.7675	2.56312	0.32487	112.4989321	21.83468649	1354.679526	6979.720092
130820-5	5	161	4.841067		20.5672	4.3061	2.5723	0.32612	162.2255874	33.96474007	939.432567	4487.006222
130821-2	18	208	5.944692		24.1623	4.6296	2.54734	0.323	190.5560164	36.51134757	799.7648299	4174.044788
130821-3	19	208	3.501228		23.5947	4.6461	2.53068	0.32085	186.1014038	36.64576079	818.908385	4158.734782
130821-10	26	217	11.74577		55.6308	15.0196	2.6581	0.3371	438.6598323	118.4325089	347.4218261	1286.808845
130821-8	27	233	10.11731		40.914	10.2562	2.41472	0.3062	322.651385	80.88129087	472.3364197	1884.242924
130820-3	2	244	10.2555		48.397	9.322	2.54929	0.32353	381.3494518	73.45371799	399.6334577	2074.775848
130821-7	34	263	5.752873		24.013	5.2782	2.5874	0.3282	189.3090683	41.6112574	805.032751	3662.470435
130821-4	20	294	10.25264		62.094	14.607	2.4385	0.30944	489.3233551	115.1084847	311.4504926	1323.968432
130806-4	13	384	10.08317		101.531	22.4	2.0977	0.26592	800.9235059	176.7015644	190.2803437	862.4711419
130821-5	30	385	8.562039		43.223	10.919	2.12077	0.26891	340.8800034	86.11315172	447.0781462	1769.764513
130821-6	32	No test										

Compb B Cylinders

Size - µm	part 36,g	%ofTotal	part 37,g	%ofTotal	Pt38,g	%ofTotal	pt39, g	%ofTotal	%<
>3360	0.1413	1.9105	0.0492	0.6915	5.647	59.3260	3.461	37.2467	62,75
3360-1000	1.9823	26.8020	1.0086	14.1759	1.9143	20.1112	3.0368	32.6815	30.0718
1000-840	0.2837	3.8358	0.2231	3.1357	0.1569	1.6484	0.2701	2.9068	27.165
840-590	0.5747	7.7703	0.6318	8.8800	0.3199	3.3608	0.4767	5.1302	22.0348
590-500	0.2546	3.4424	0.3068	4.3121	0.1242	1.3048	0.1961	2.1104	19.9244
500-420	0.232	3.1368	0.2958	4.1575	0.1212	1.2733	0.1718	1.8489	18.0755
420-355	0.3046	4.1184	0.4262	5.9902	0.1608	1.6893	0.2294	2.4688	15.6067
355-250	0.419	5.6651	0.5921	8.3220	0.1875	1.9698	0.2833	3.0488	12.5579
250-212	0.2534	3.4261	0.3323	4.6705	0.0308	0.3236	0.156	1.6788	10.8791
212-180	0.1431	1.9348	0.2212	3.1090	0.0581	0.6104	0.11	1.1838	9.6953
180-150	0.229	3.0962	0.2864	4.0254	0.0888	0.9329	0.1628	1.7520	7.9433
150-125	0.2292	3.0989	0.334	4.6944	0.0822	0.8636	0.1481	1.5938	6.3495
125-106	0.3112	4.2076	0.3434	4.8265	0.0912	0.9581	0.1244	1.3388	5.017
<106	2.038	27.5551	2.064	29.0095	0.5357	5.6279	0.4656	5.0107	
Total	7.3961	100.0000	7.1149	100.0000	9.5186	100.0000	9.2921	100.0000	
Weight Recovered	7.6707		7.2743		9.6639		9.5825		
Percentage	96.42		97.81		98.50		96.97		
vel - ft/s	**435**		**425**		**110**		**107**		

spilled


Cylinders
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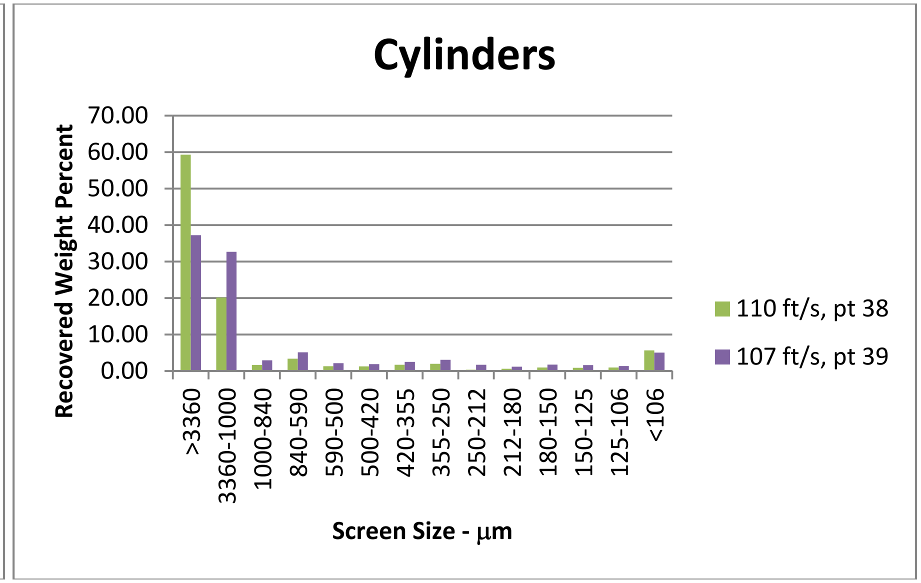
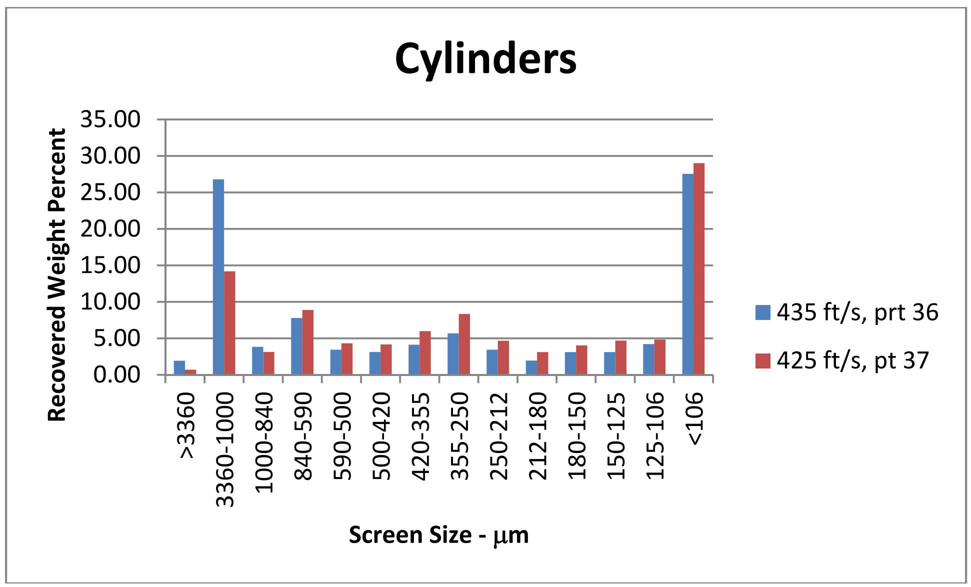
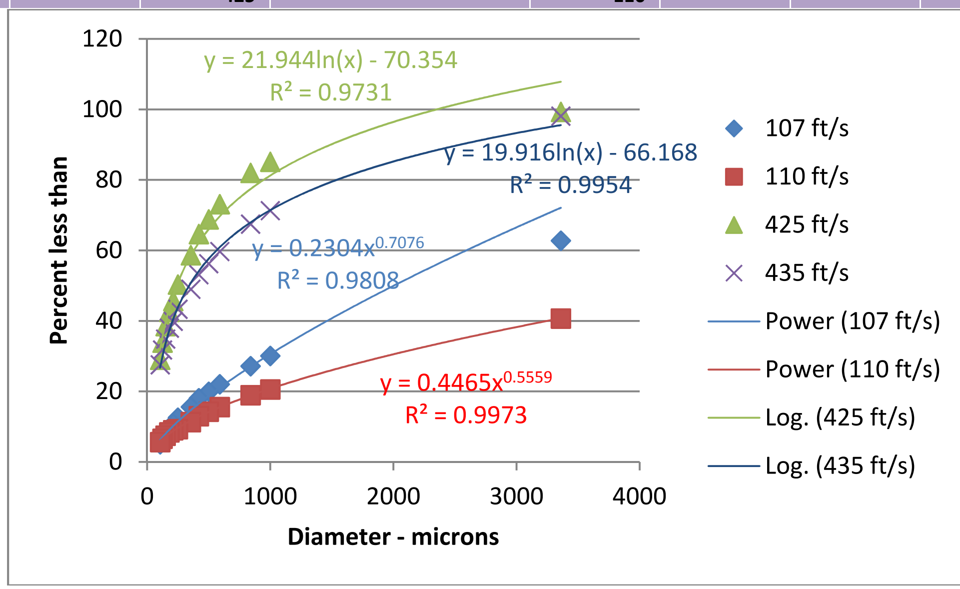
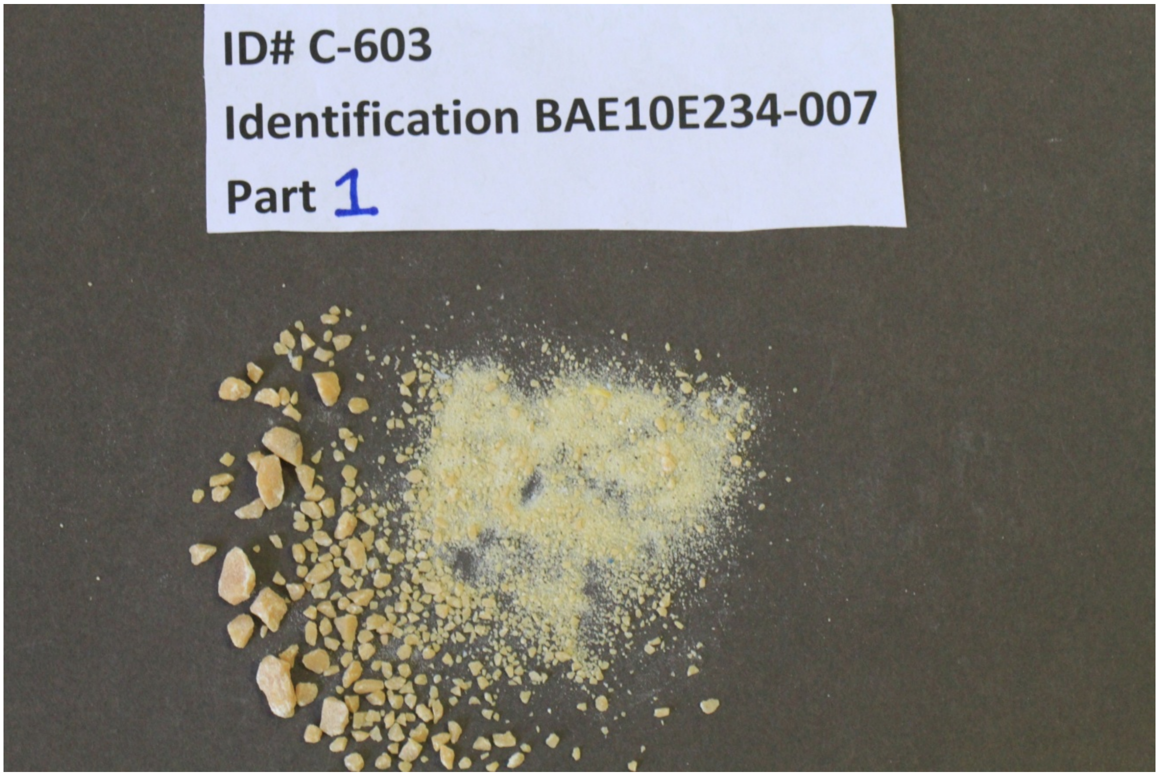
60.00
50.00
40.00
30.00
20.00
10.00
0.00
>3360
3360-1000
1000-840
840-590
590-500
500-420
420-355
355-250
250-212
212-180
180-150
150-125
125-106
<106
435 ft/s, prt 36
425 ft/s, pt 37
110 ft/s, pt 38
107 ft/s, pt 39


Cylinders
Recovered Weight Percent
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
>3360
3360-1000
1000-840
840-590
590-500
500-420
420-355
355-250
250-212
212-180
180-150
150-125
125-106
<106
Screen Size - µm
110 ft/s, pt 38
107 ft/s, pt 39


Cylinders
Recovered Weight Percent
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
>3360
3360-1000
1000-840
840-590
590-500
500-420
420-355
355-250
250-212
212-180
180-150
150-125
125-106
<106
Screen Size - µm
435 ft/s, prt 36
425 ft/s, pt 37

Size - µm	part 36,g	%ofTotal	%<	part 37,g	%ofTotal	%<	Pt38,g	%ofTotal	%<	pt39, g	%ofTotal	%<	
>3360	0.1413	1.9105	98.0895	0.0492	0.6915	99.3085	5.647	59.3260	40.6740	3.461	37.2467	62.75	3360
3360-1000	1.9823	26.8020	71.2876	1.0086	14.1759	85.1326	1.9143	20.1112	20.5629	3.0368	32.6815	30.0718	1000.0000
1000-840	0.2837	3.8358	67.4518	0.2231	3.1357	81.9969	0.1569	1.6484	18.9145	0.2701	2.9068	27.165	840.0000
840-590	0.5747	7.7703	59.6815	0.6318	8.8800	73.1170	0.3199	3.3608	15.5538	0.4767	5.1302	22.0348	590.0000
590-500	0.2546	3.4424	56.2391	0.3068	4.3121	68.8049	0.1242	1.3048	14.2489	0.1961	2.1104	19.9244	500.0000
500-420	0.232	3.1368	53.1023	0.2958	4.1575	64.6474	0.1212	1.2733	12.9756	0.1718	1.8489	18.0755	420.0000
420-355	0.3046	4.1184	48.9839	0.4262	5.9902	58.6572	0.1608	1.6893	11.2863	0.2294	2.4688	15.6067	355.0000
355-250	0.419	5.6651	43.3188	0.5921	8.3220	50.3352	0.1875	1.9698	9.3165	0.2833	3.0488	12.5579	250.0000
250-212	0.2534	3.4261	39.8926	0.3323	4.6705	45.6647	0.0308	0.3236	8.9929	0.156	1.6788	10.8791	212.0000
212-180	0.1431	1.9348	37.9578	0.2212	3.1090	42.5558	0.0581	0.6104	8.3825	0.11	1.1838	9.6953	180.0000
180-150	0.229	3.0962	34.8616	0.2864	4.0254	38.5304	0.0888	0.9329	7.4496	0.1628	1.7520	7.9433	150.0000
150-125	0.2292	3.0989	31.7627	0.334	4.6944	33.8360	0.0822	0.8636	6.5861	0.1481	1.5938	6.3495	125.0000
125-106	0.3112	4.2076	27.5551	0.3434	4.8265	29.0095	0.0912	0.9581	5.6279	0.1244	1.3388	5.017	106.0000
<106	2.038	27.5551		2.064	29.0095		0.5357	5.6279		0.4656	5.0107		
Total	7.3961	100.0000	50%=341	7.1149	100.0000	50%-241	9.5186	100.0000	50%=4855	9.2921	100.0000	50% = 2004	
Weight Recovered	7.6707			7.2743			9.6639			9.5825			
Percentage	96.42			97.81			98.50			96.97			
vel - ft/s	**435**			**425**			**110**			**107**			

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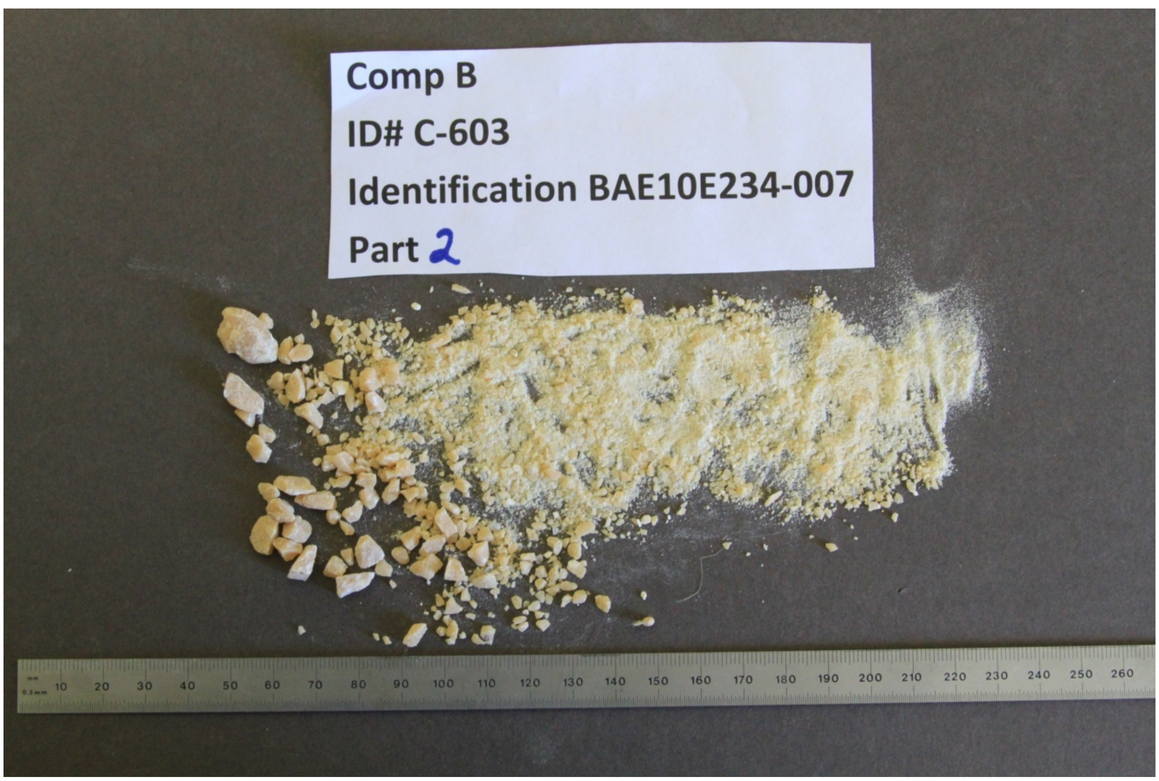
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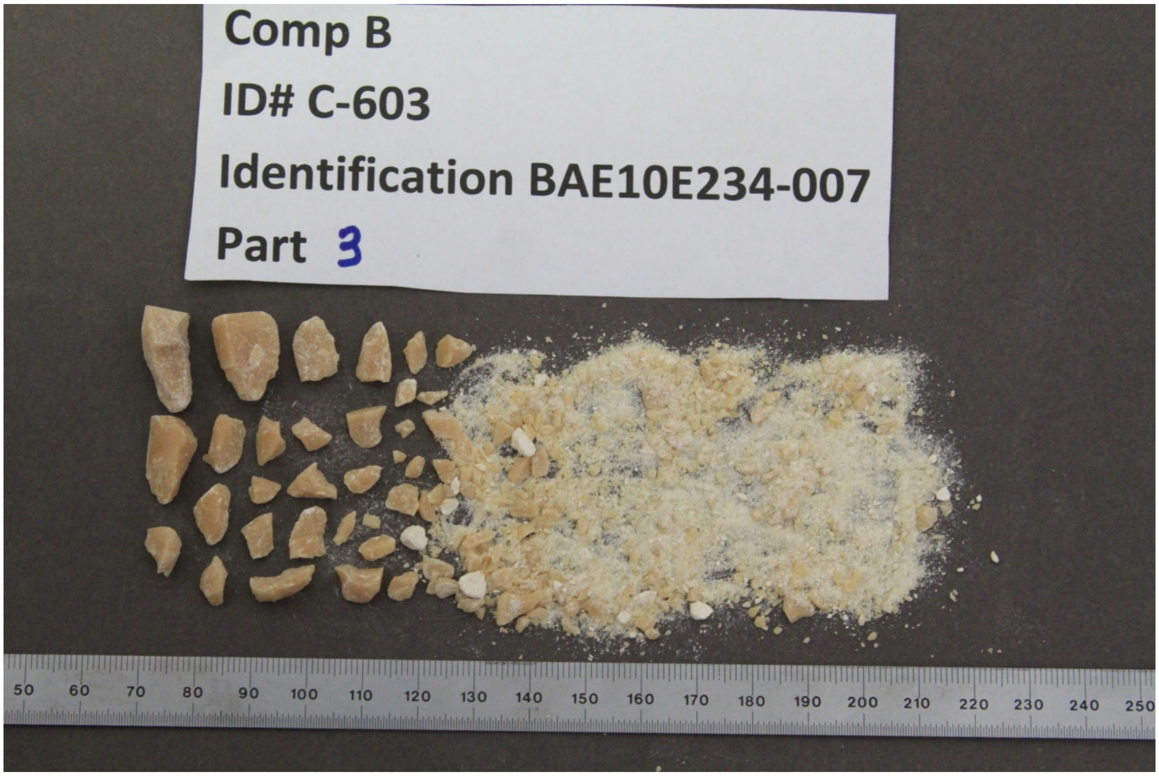
Identification BAE10E234-007
Part 2


Comp B
ID# C-603
Identification BAE10E234-007
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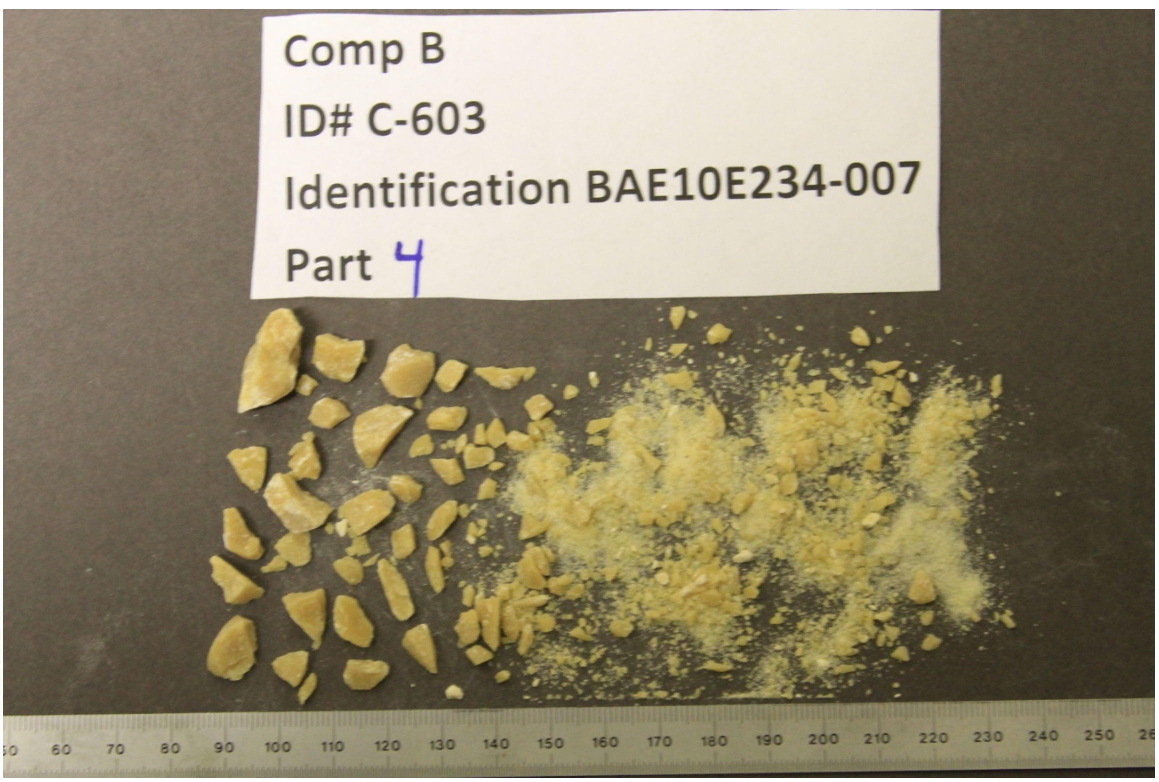
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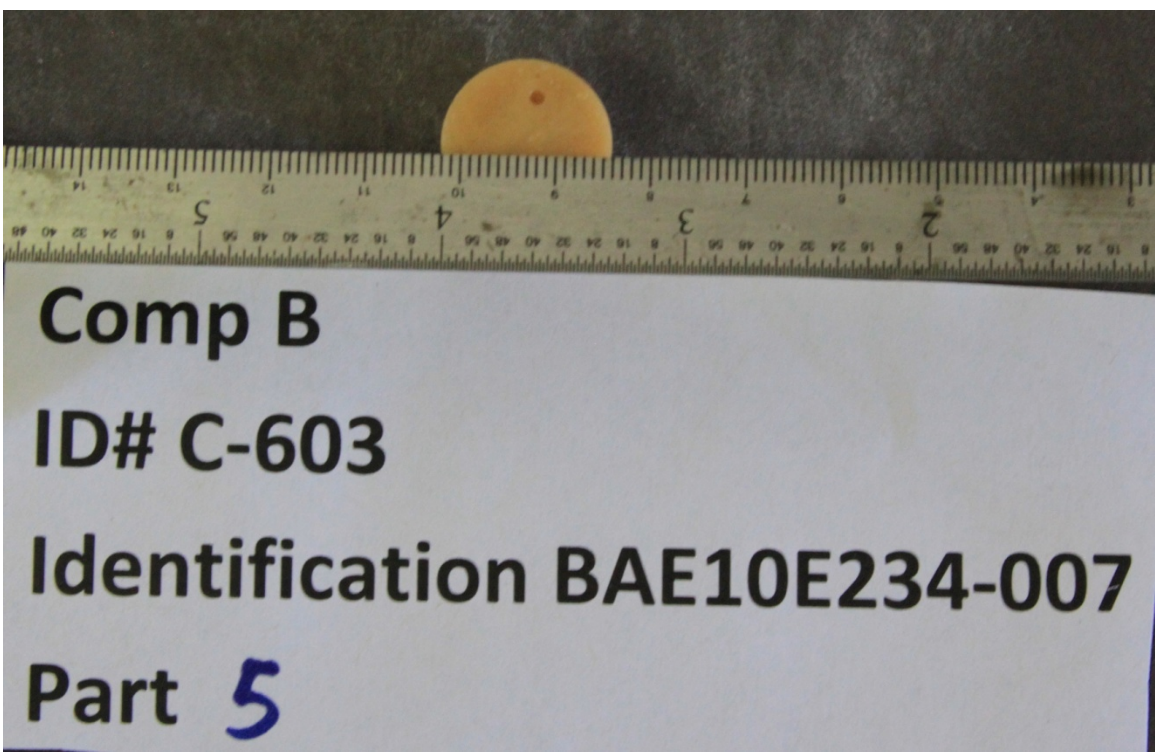
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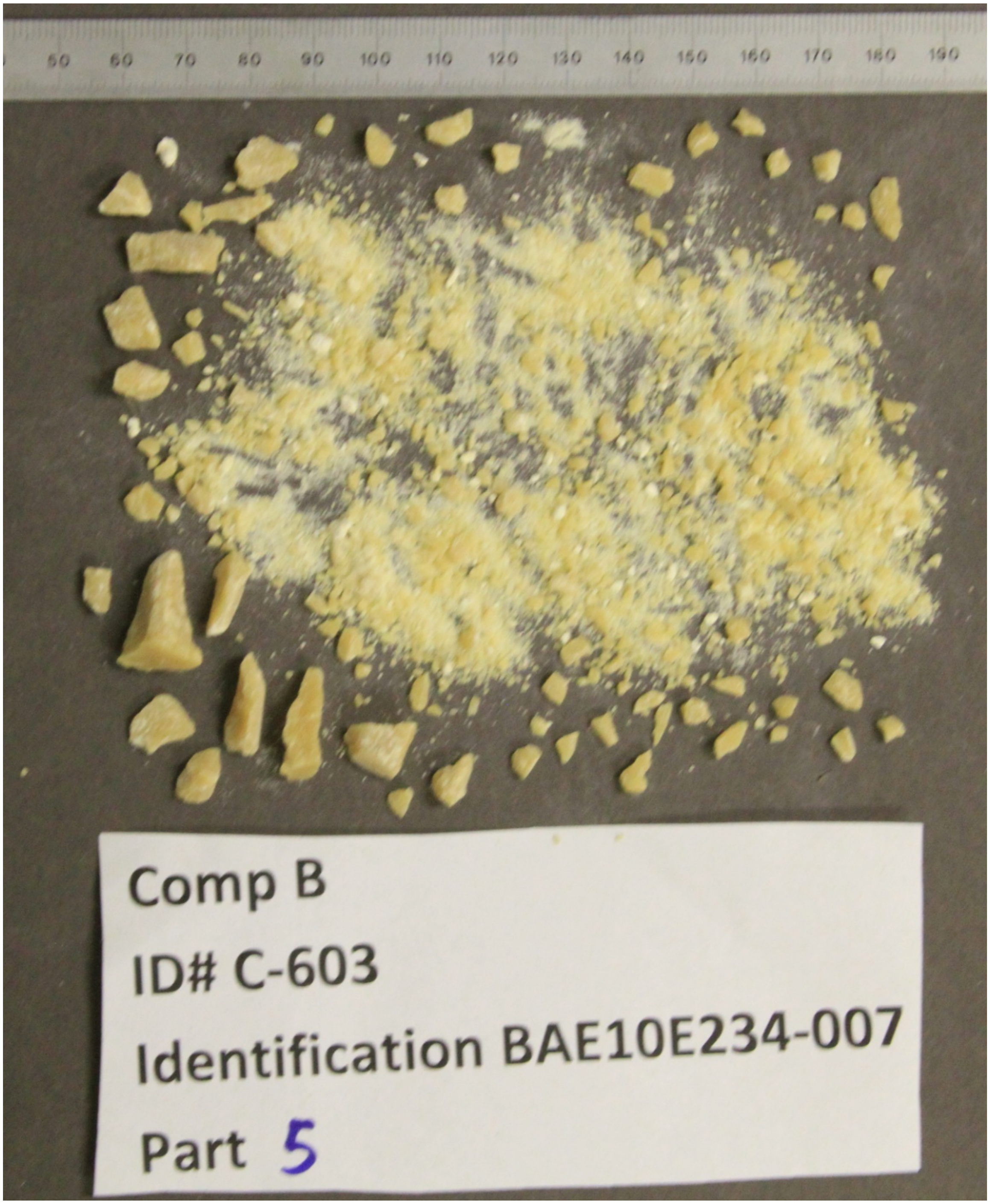
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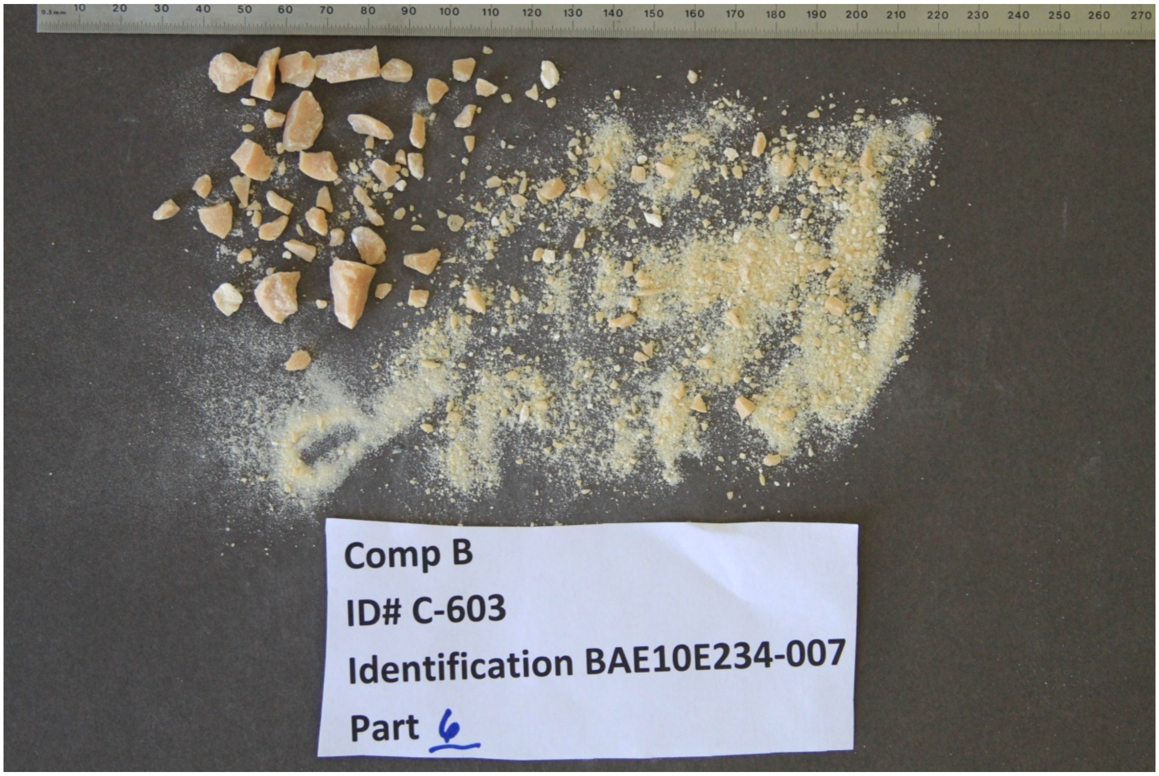
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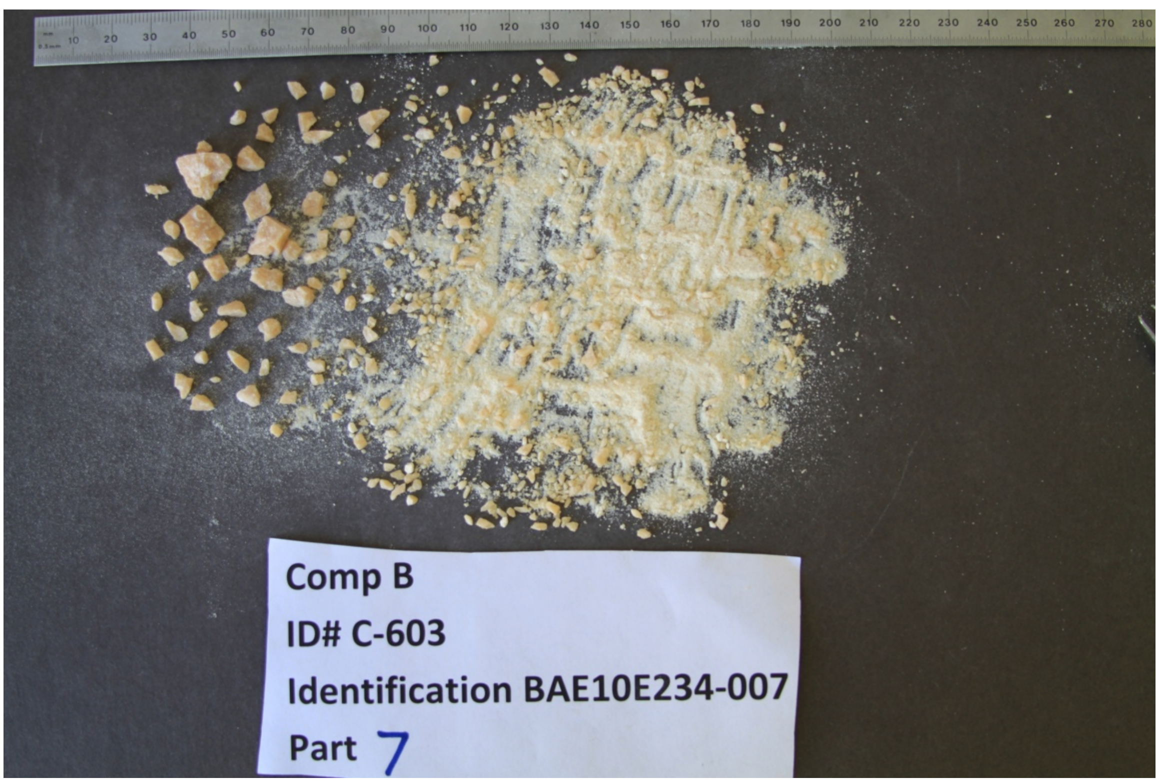
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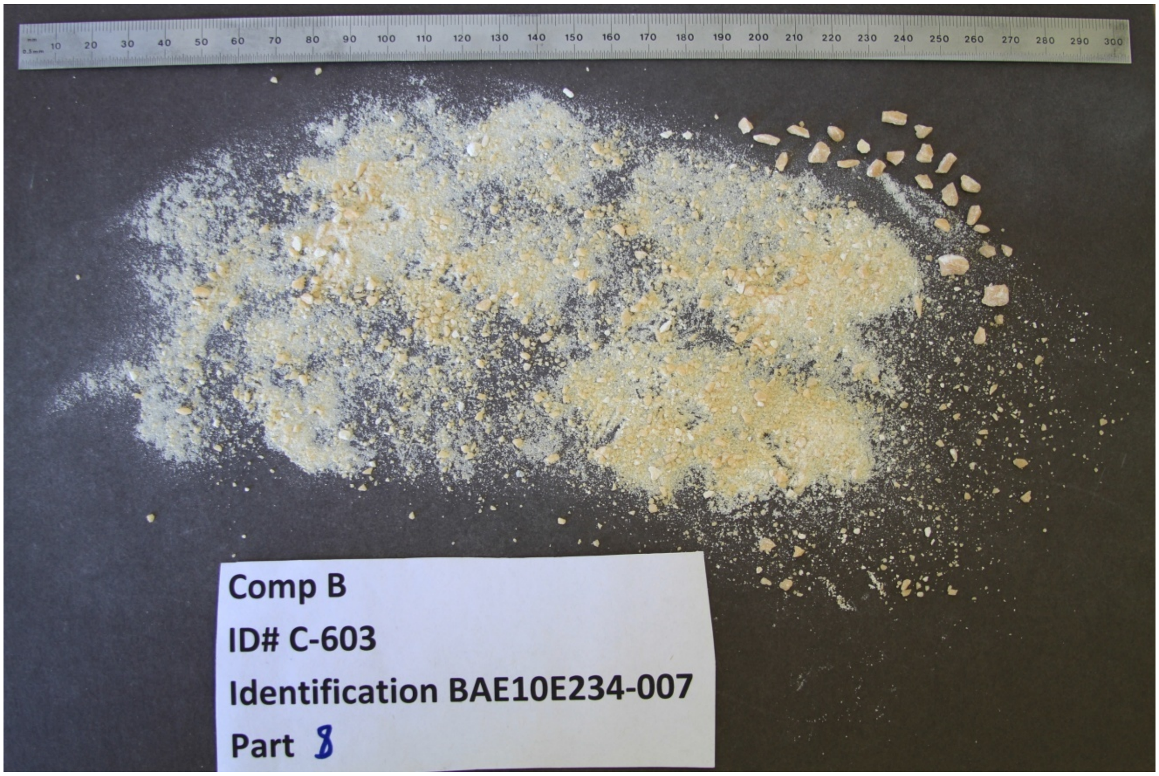
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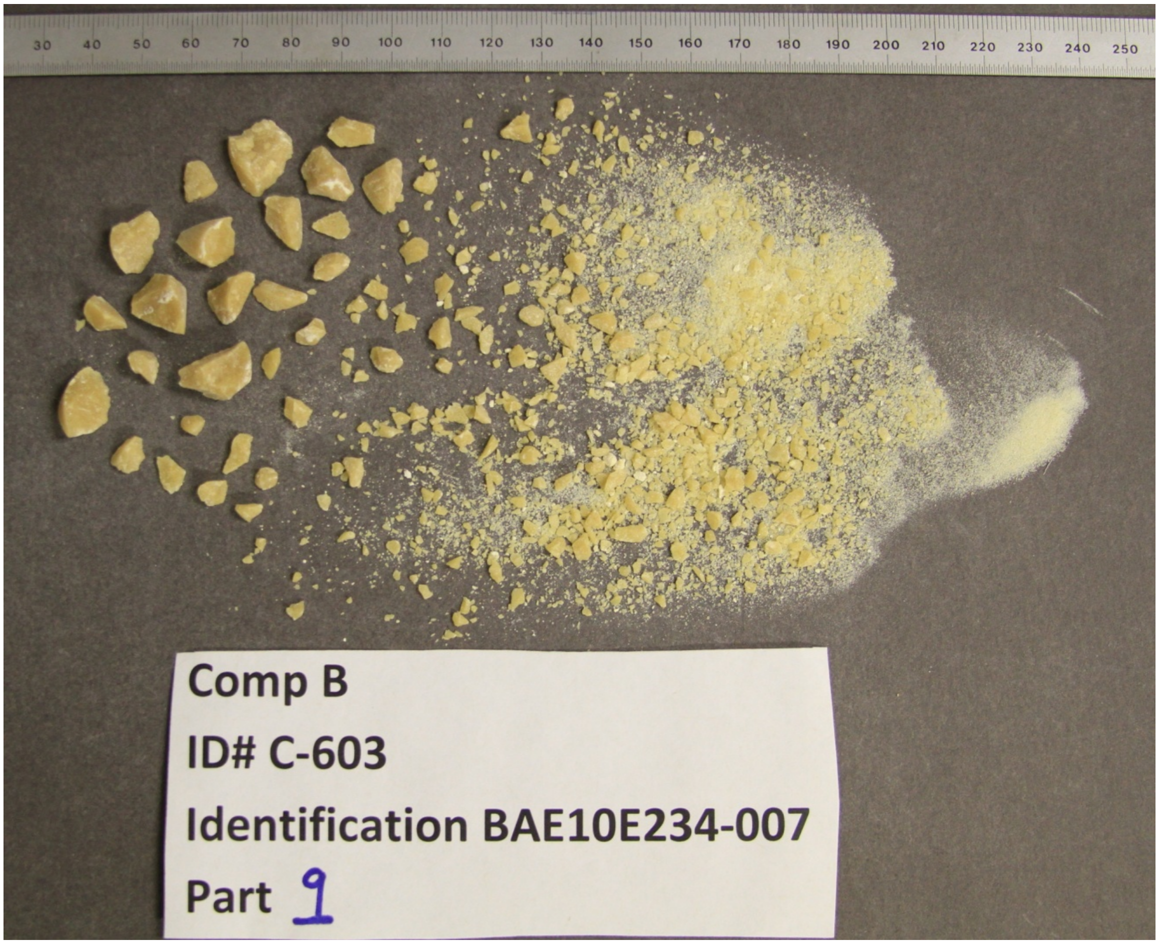
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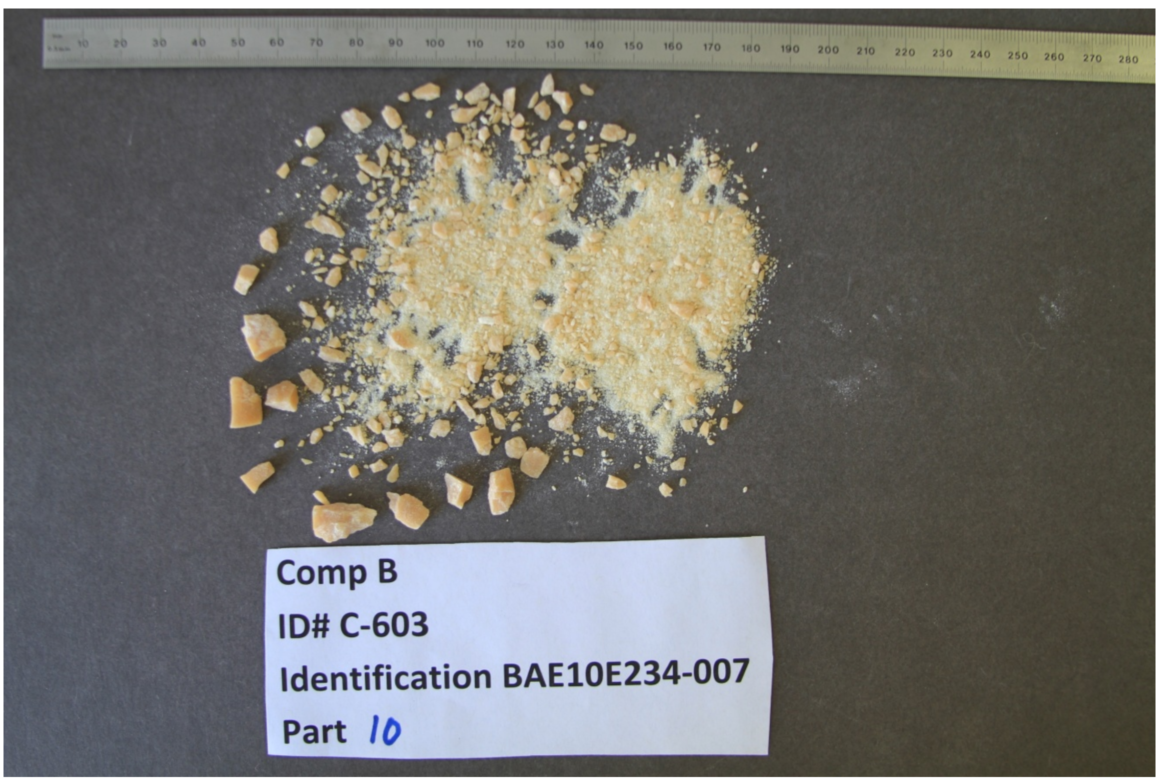
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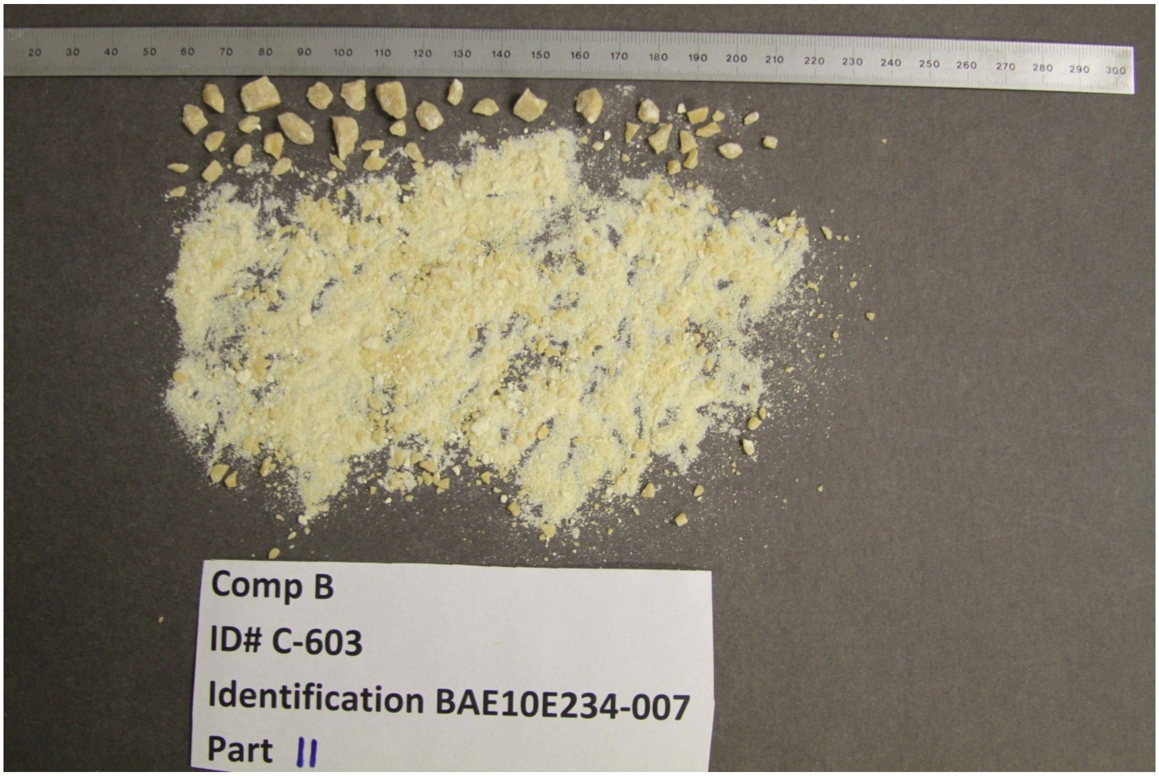
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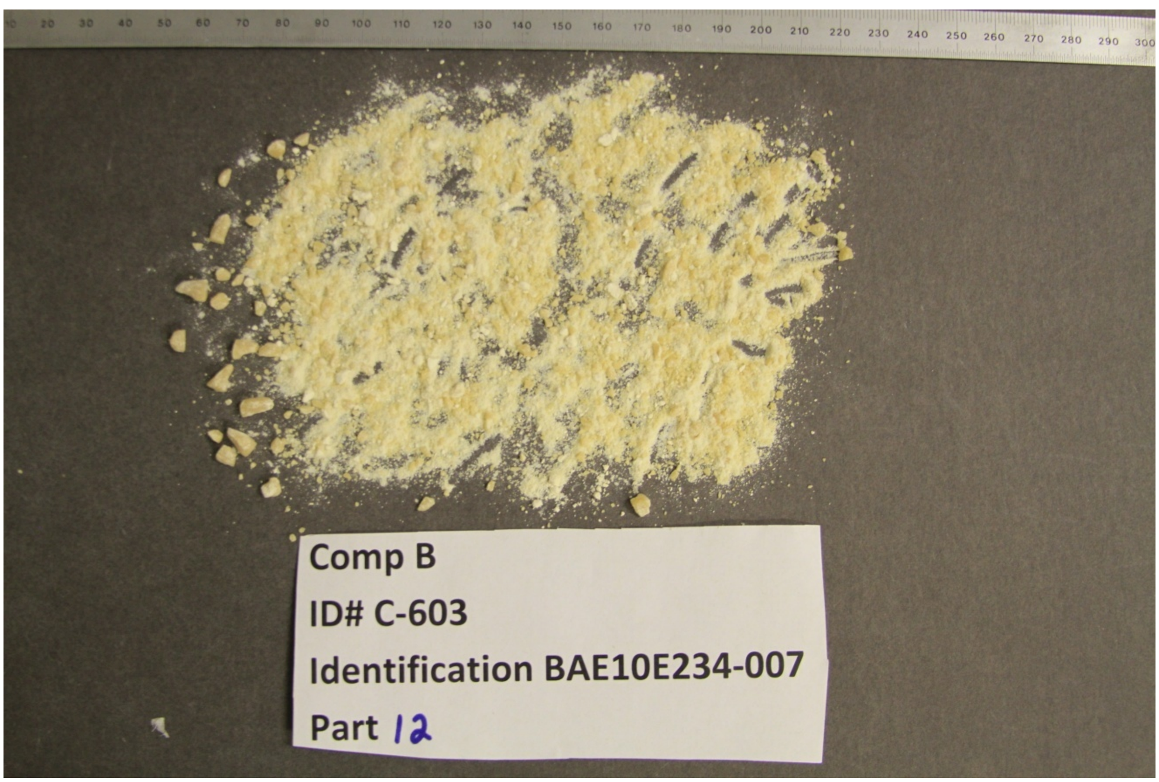
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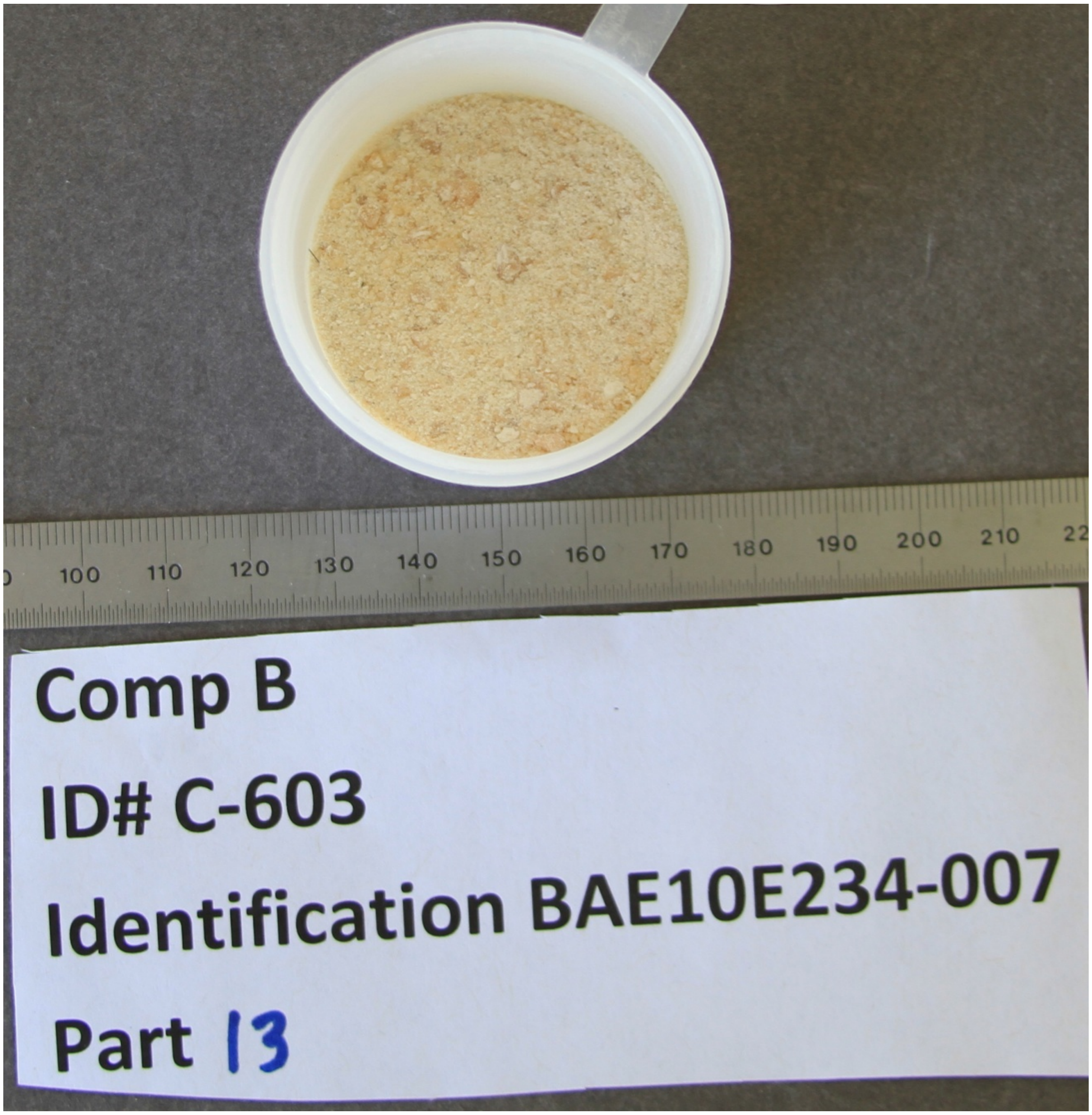
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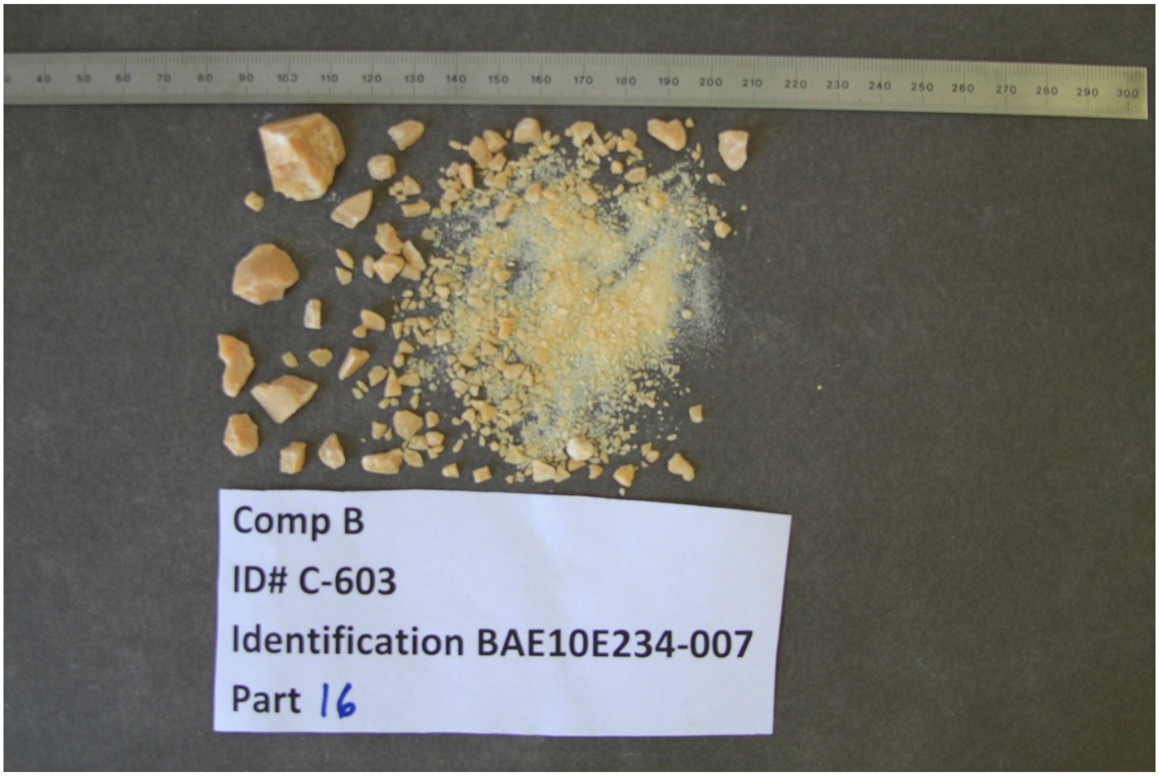
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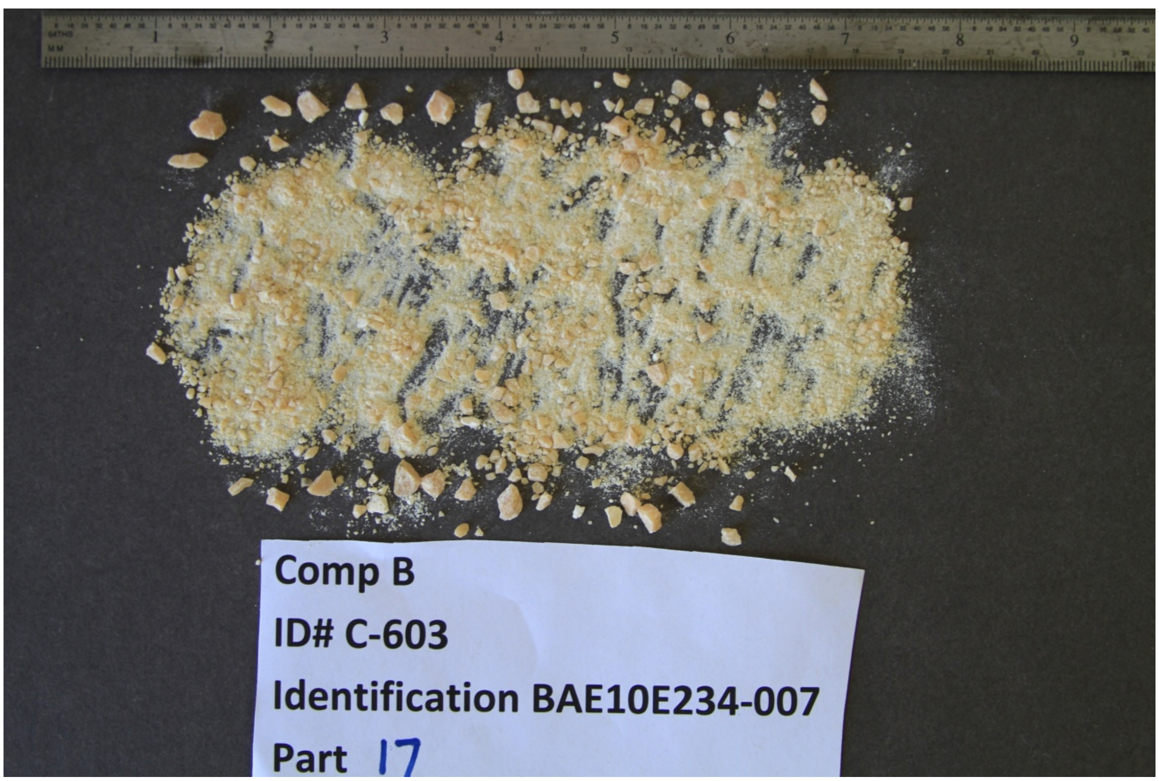
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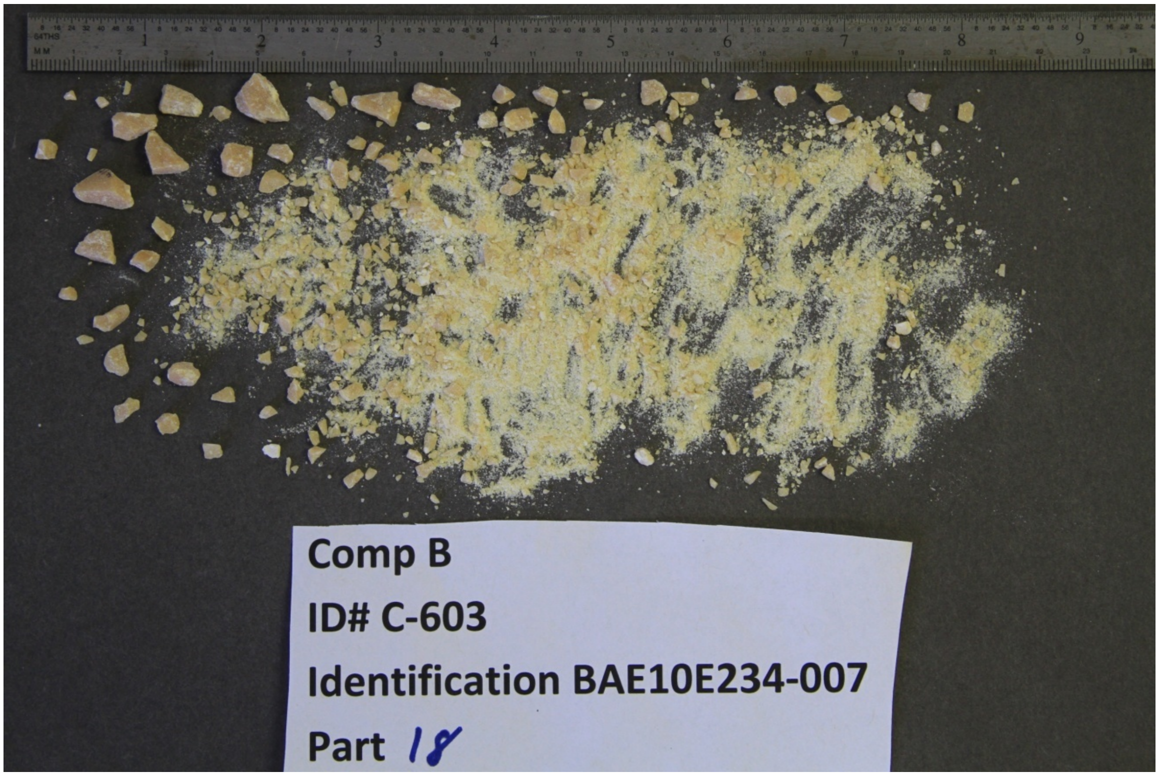
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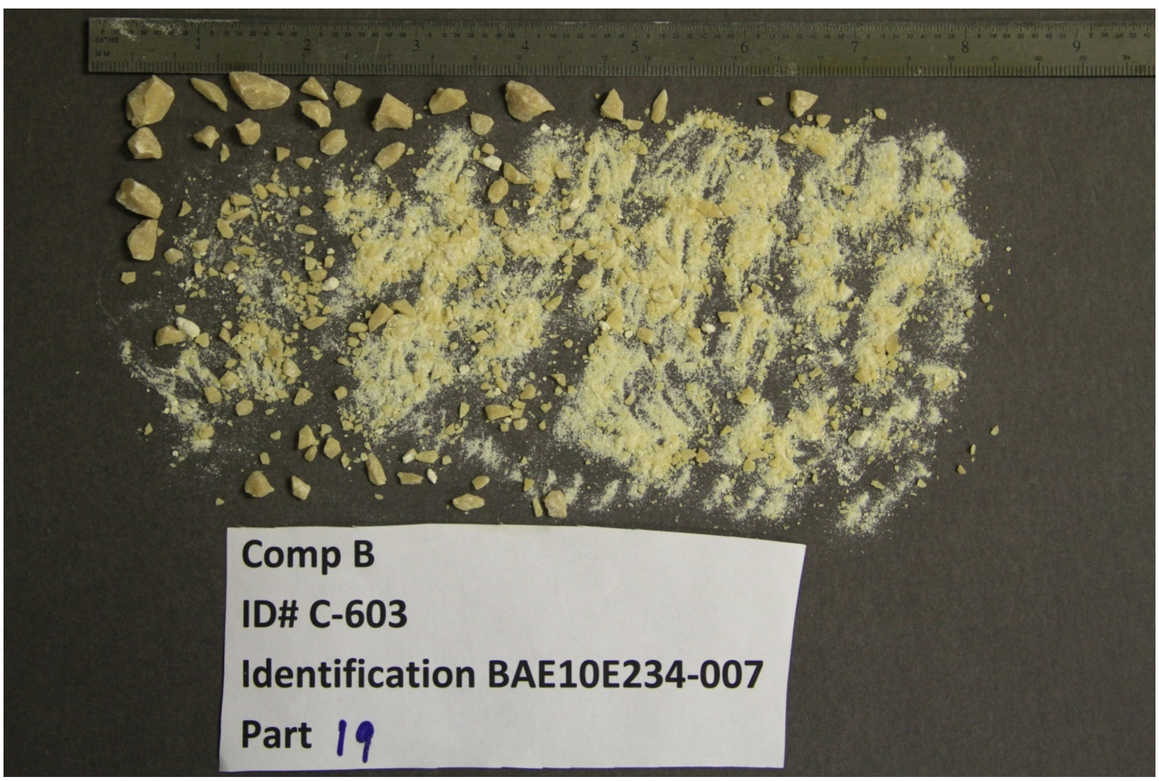
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Part 20


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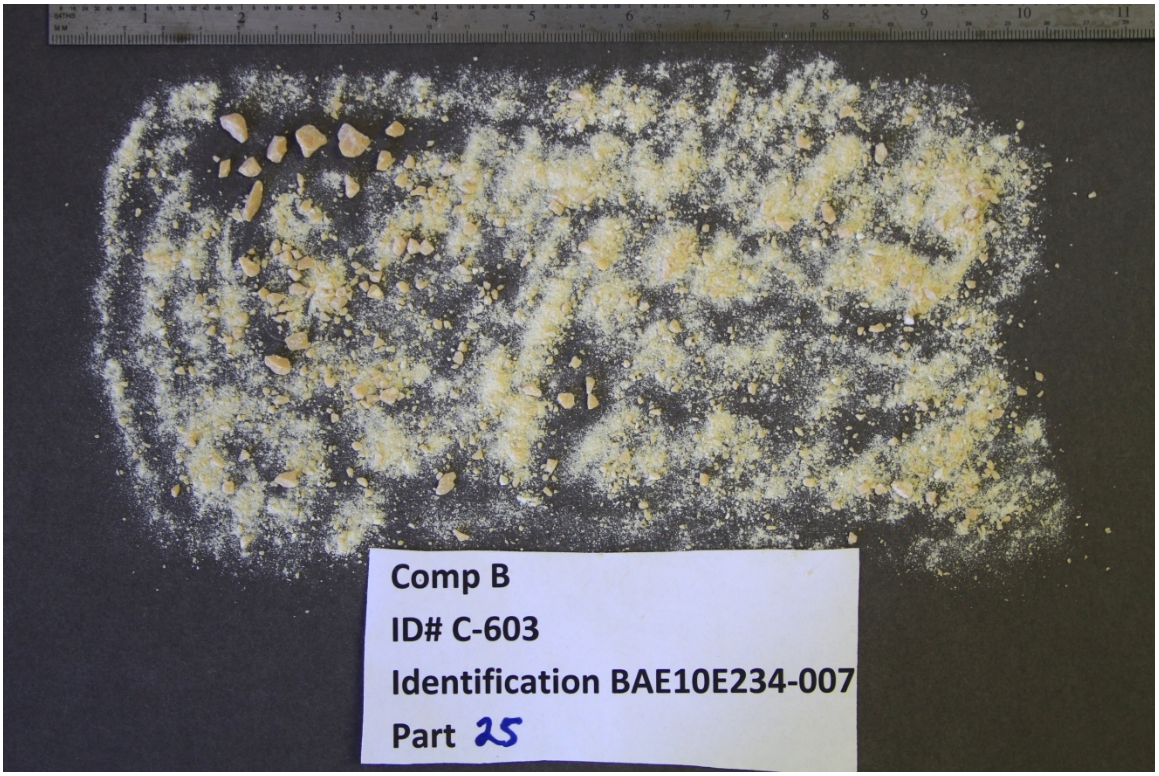
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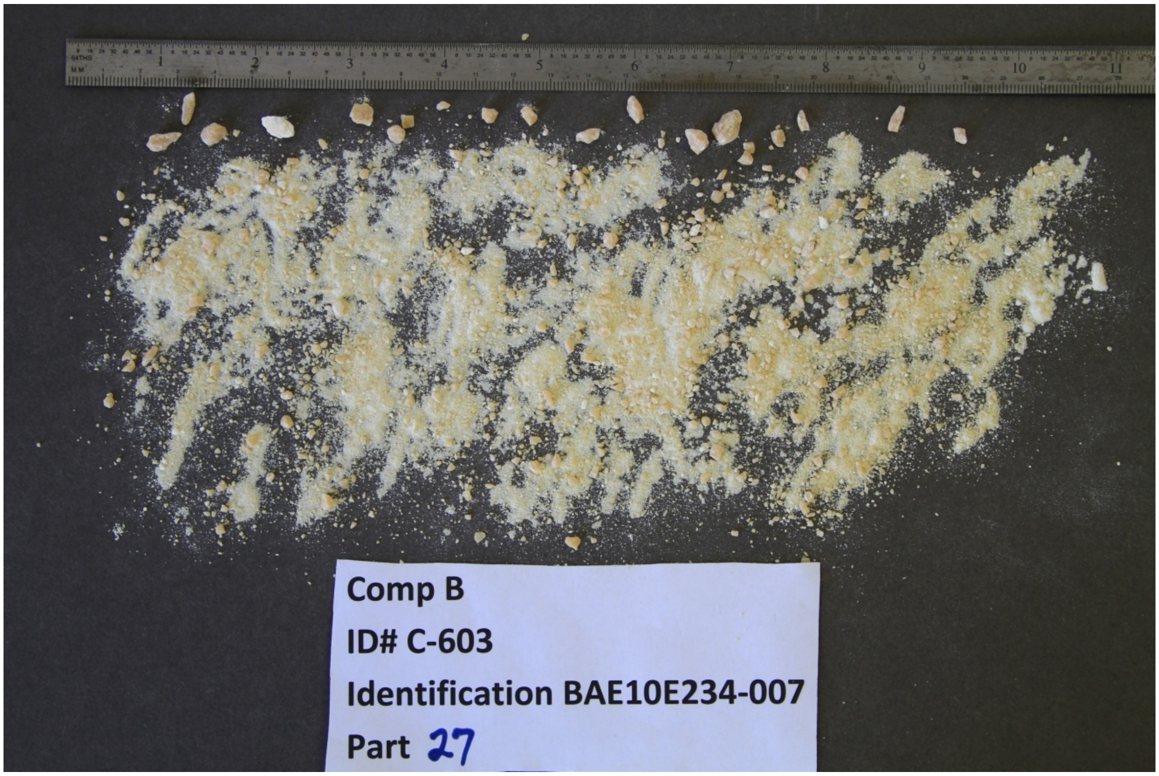
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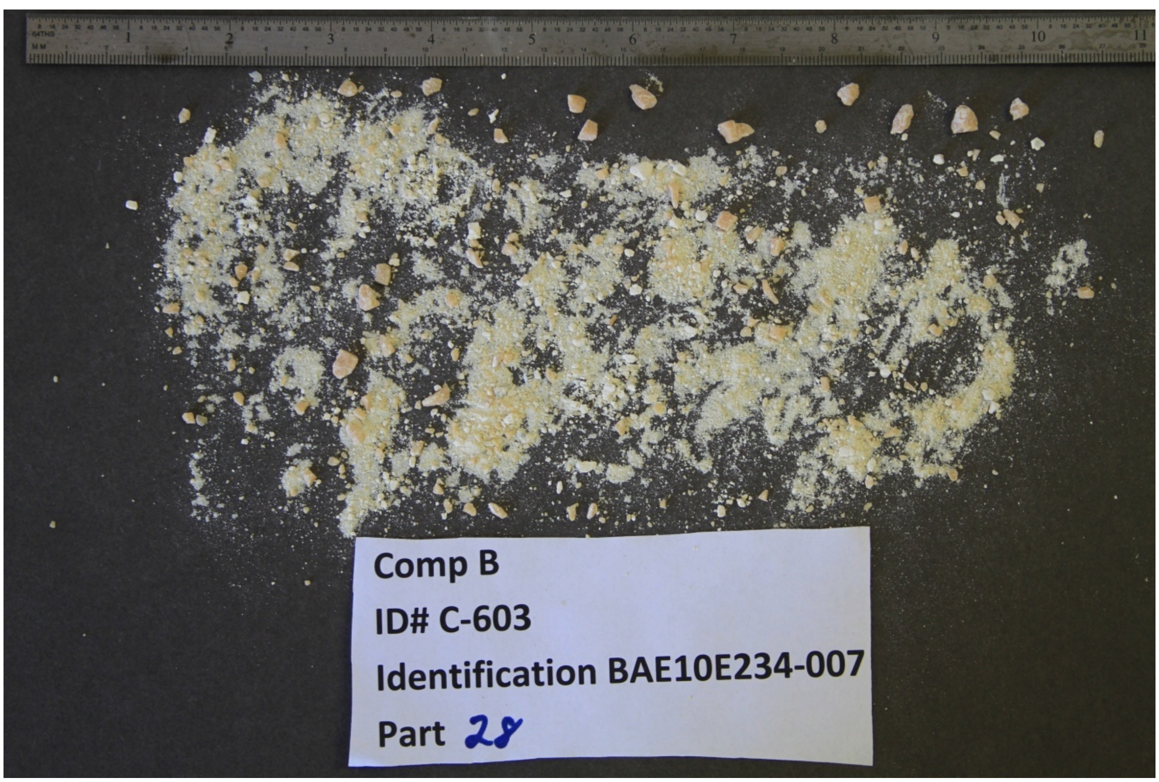
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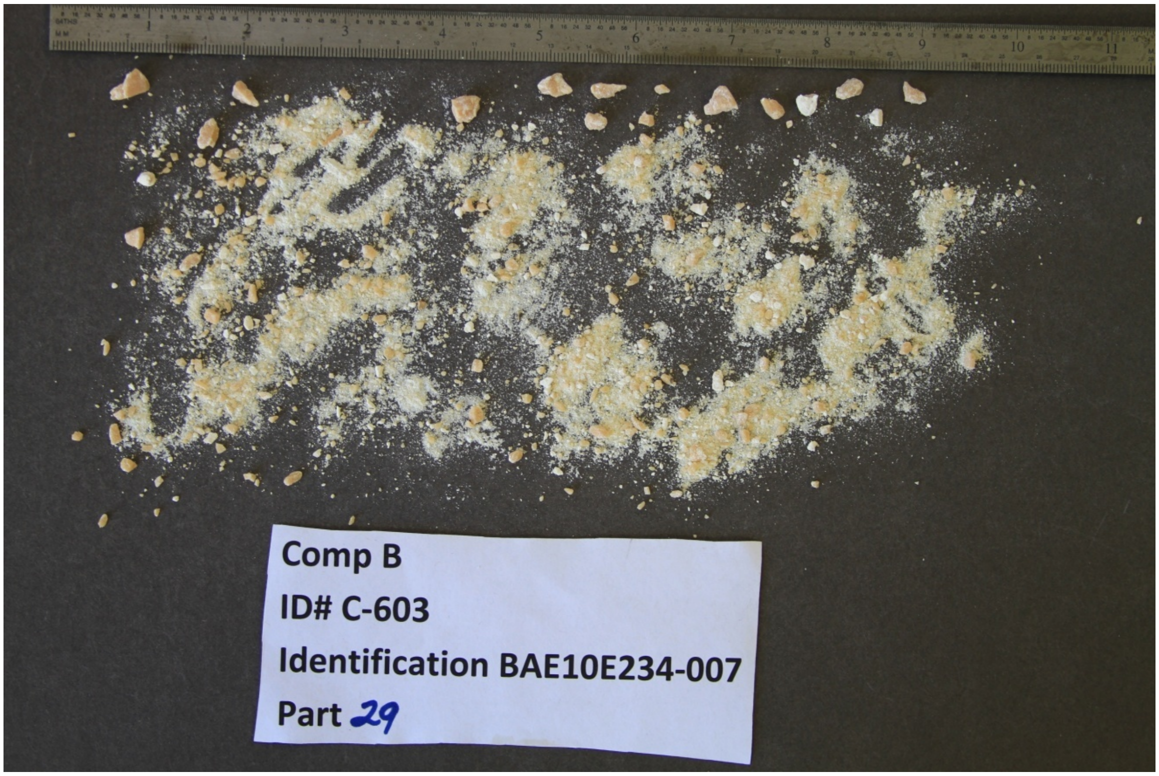
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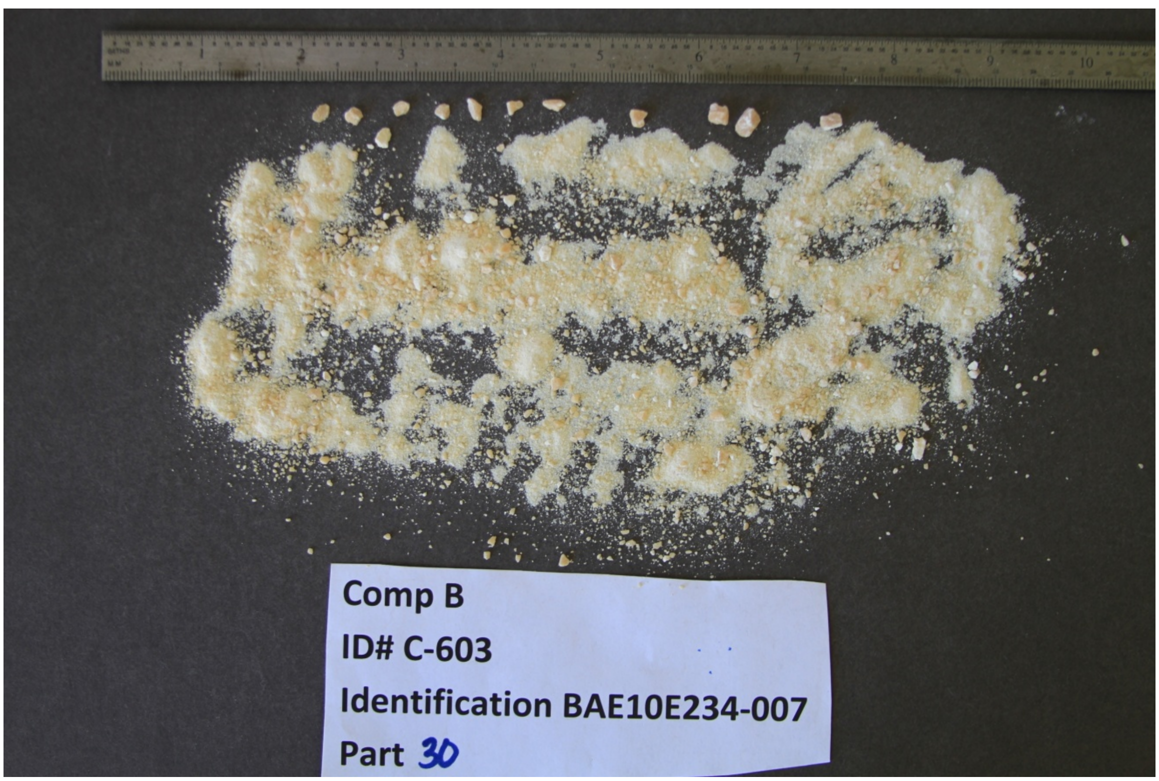
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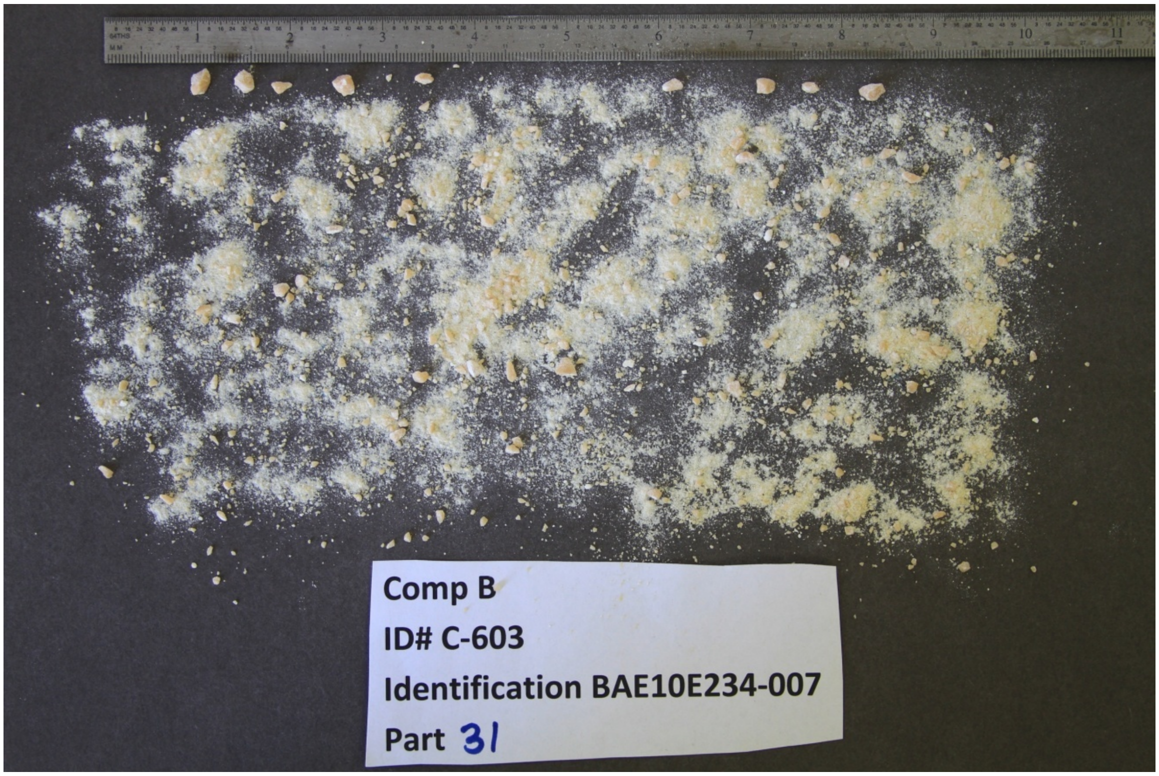
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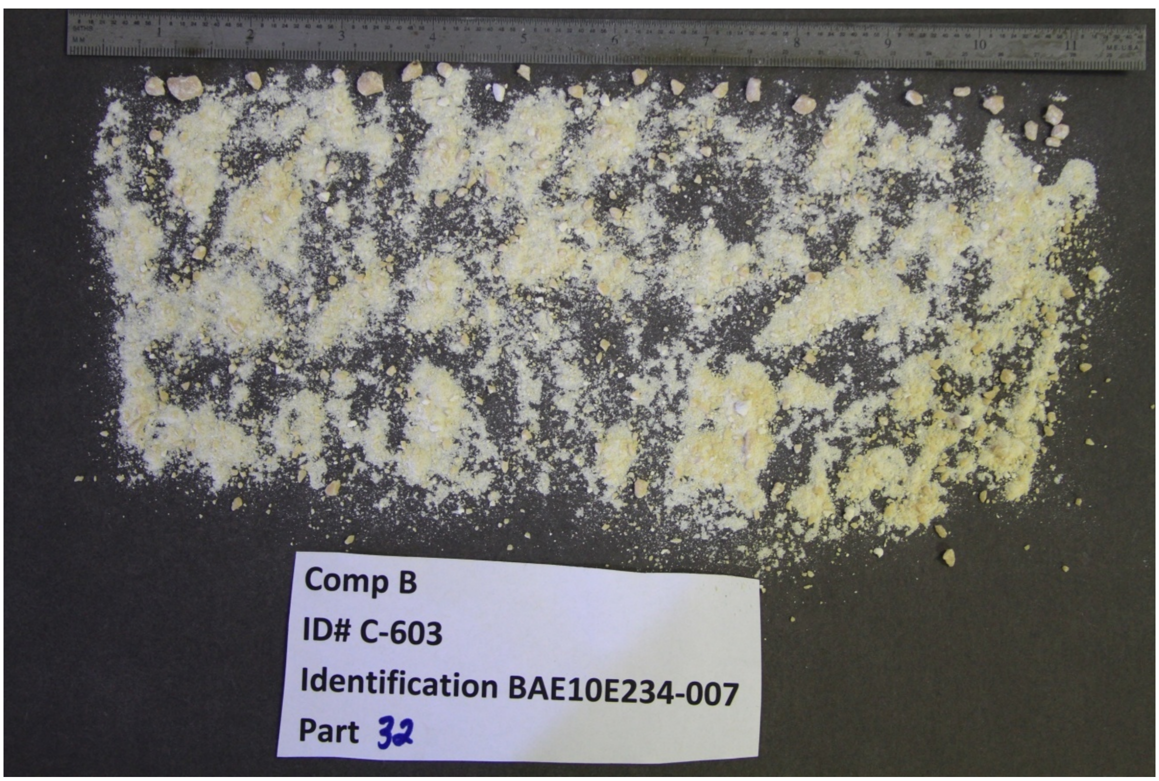
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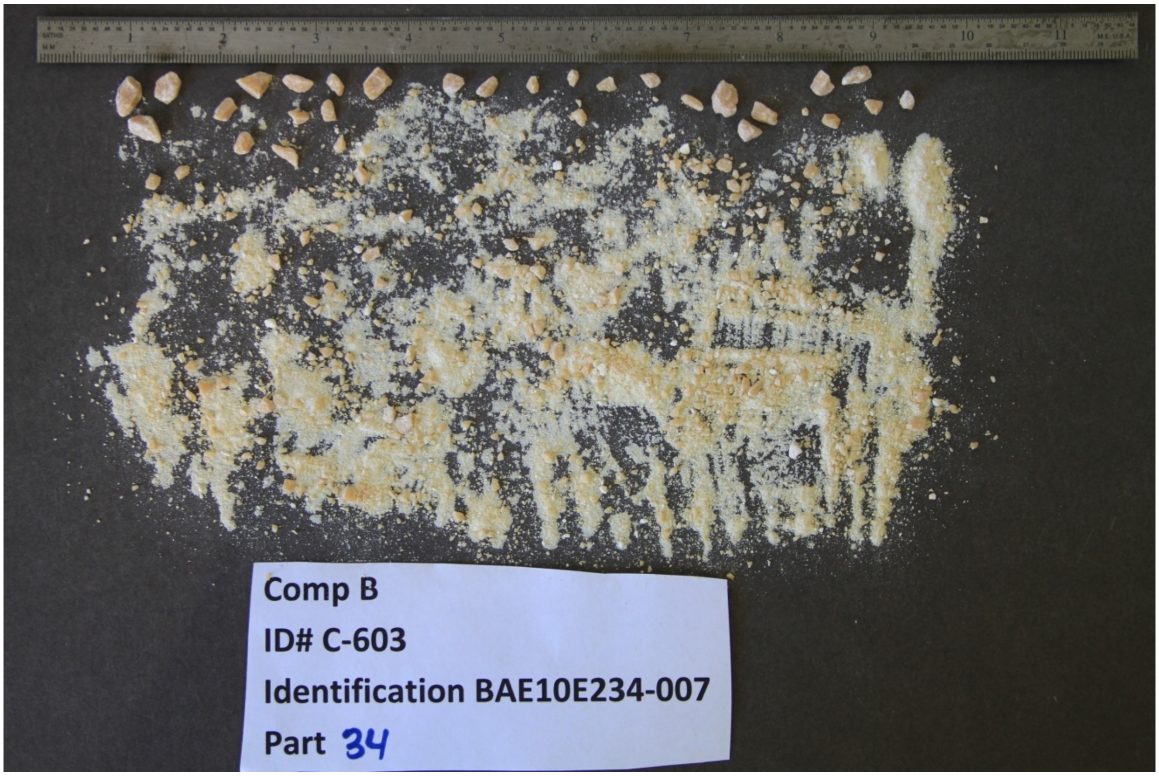
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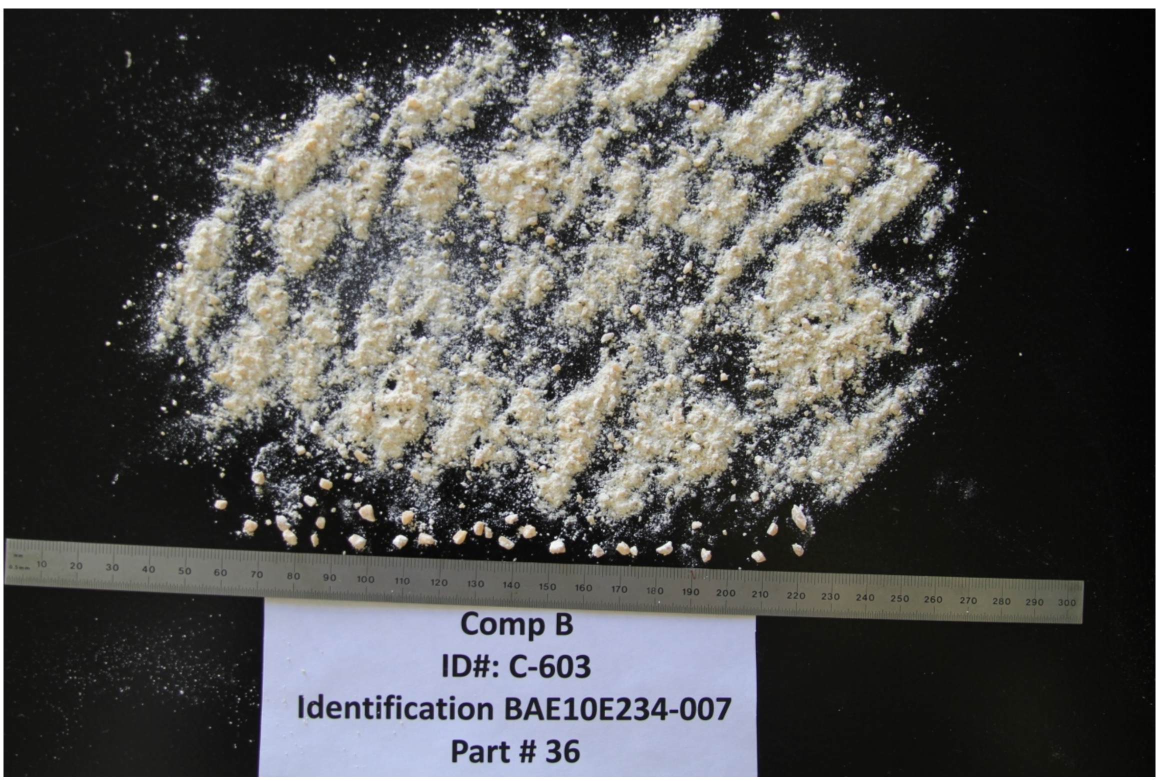
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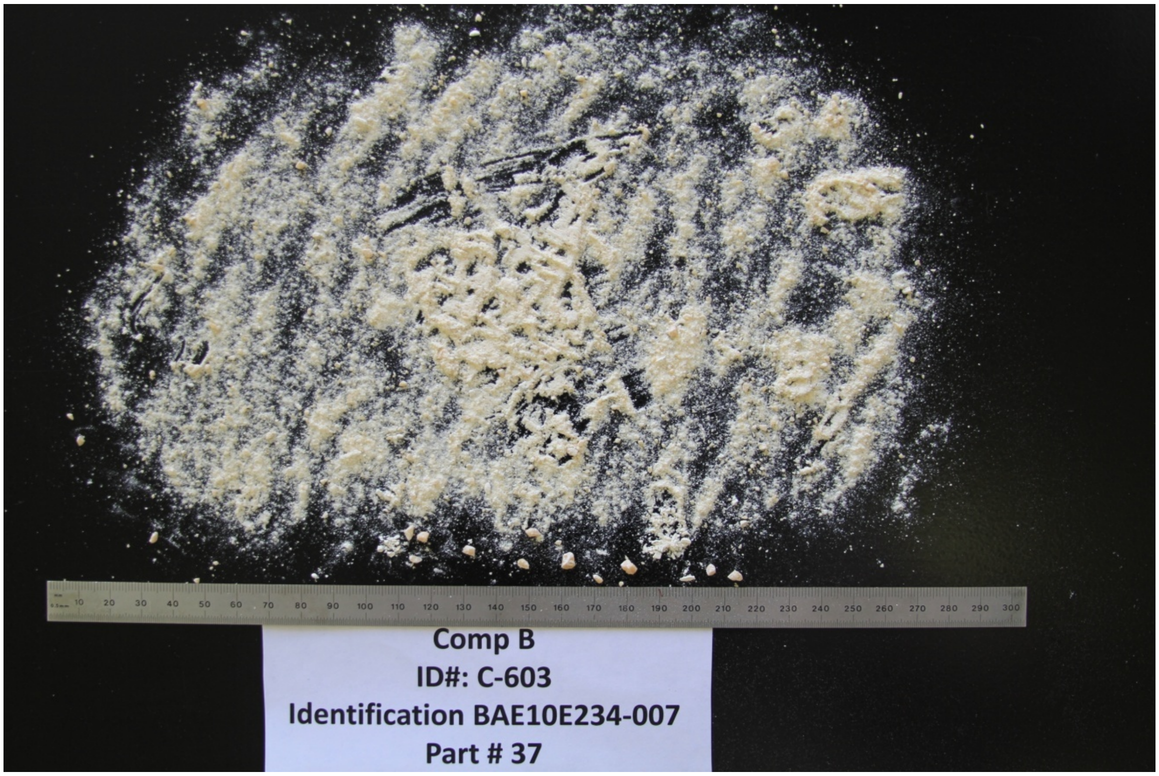
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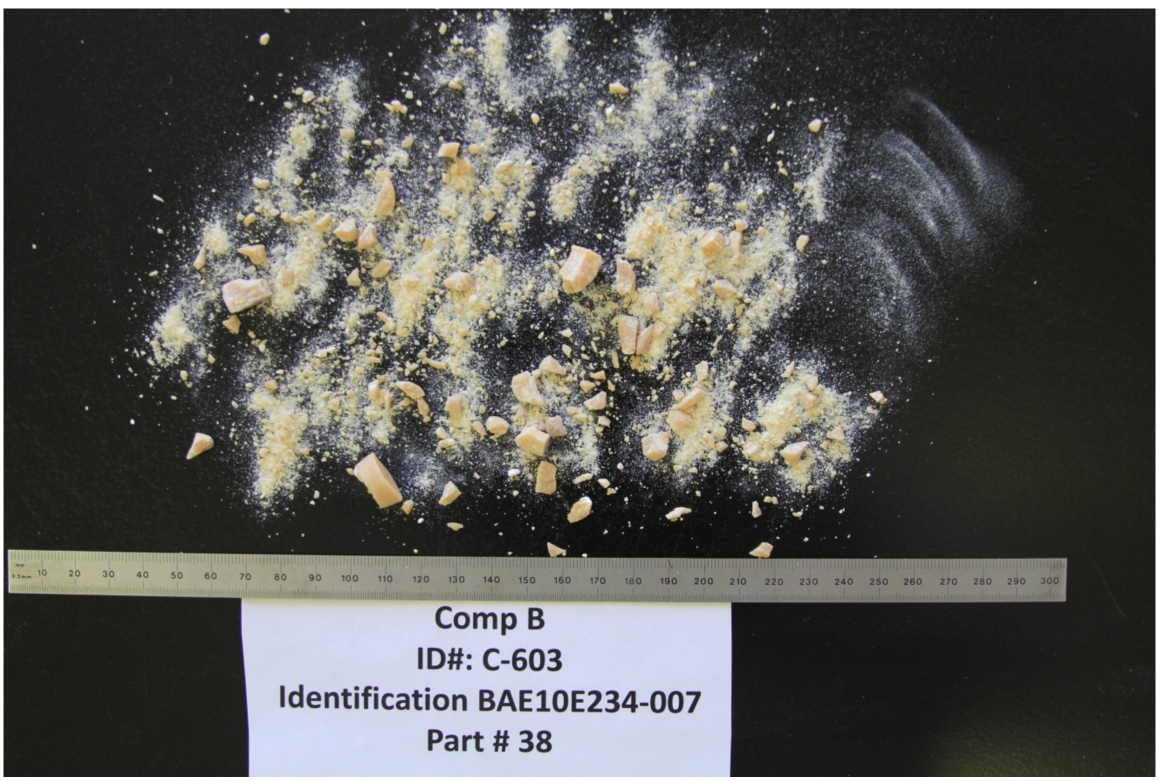
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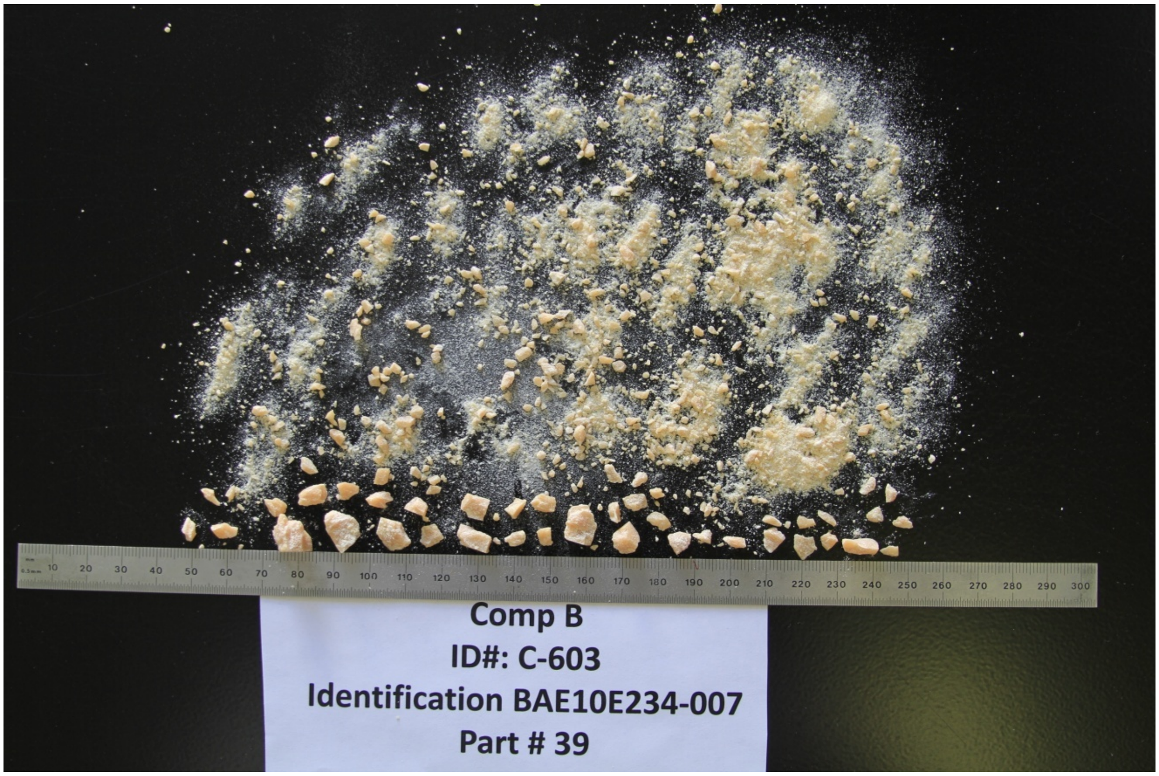
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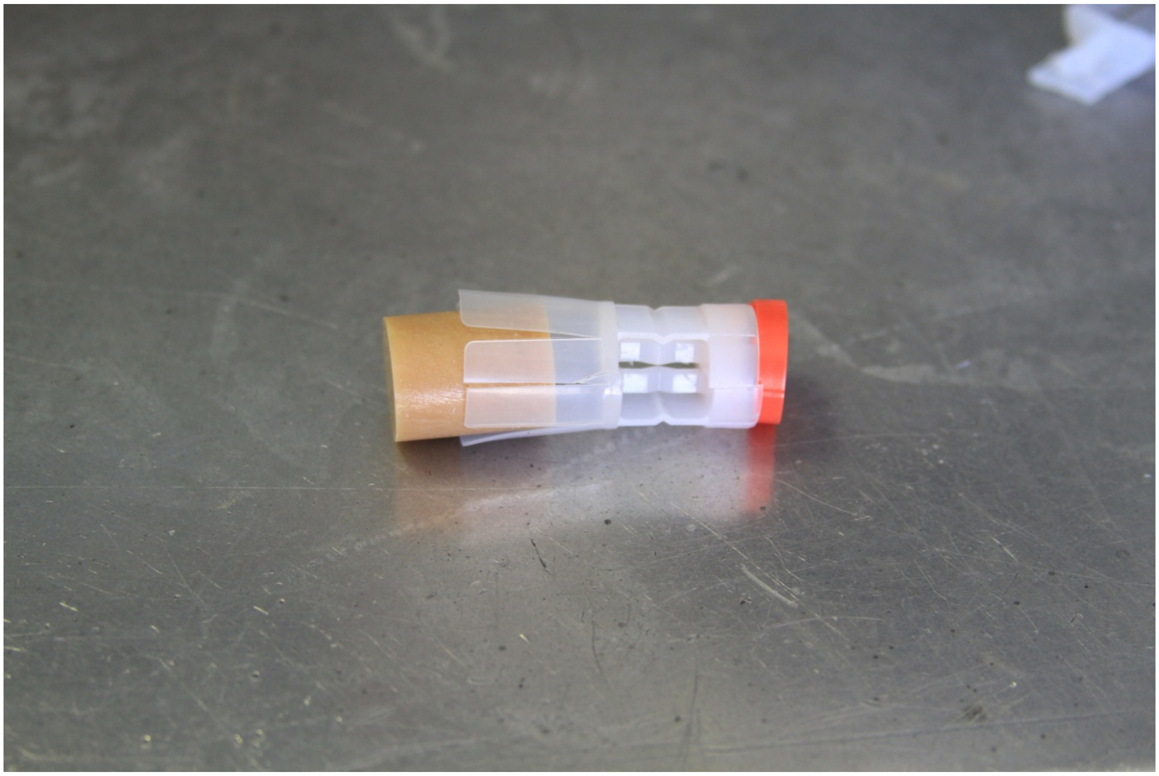

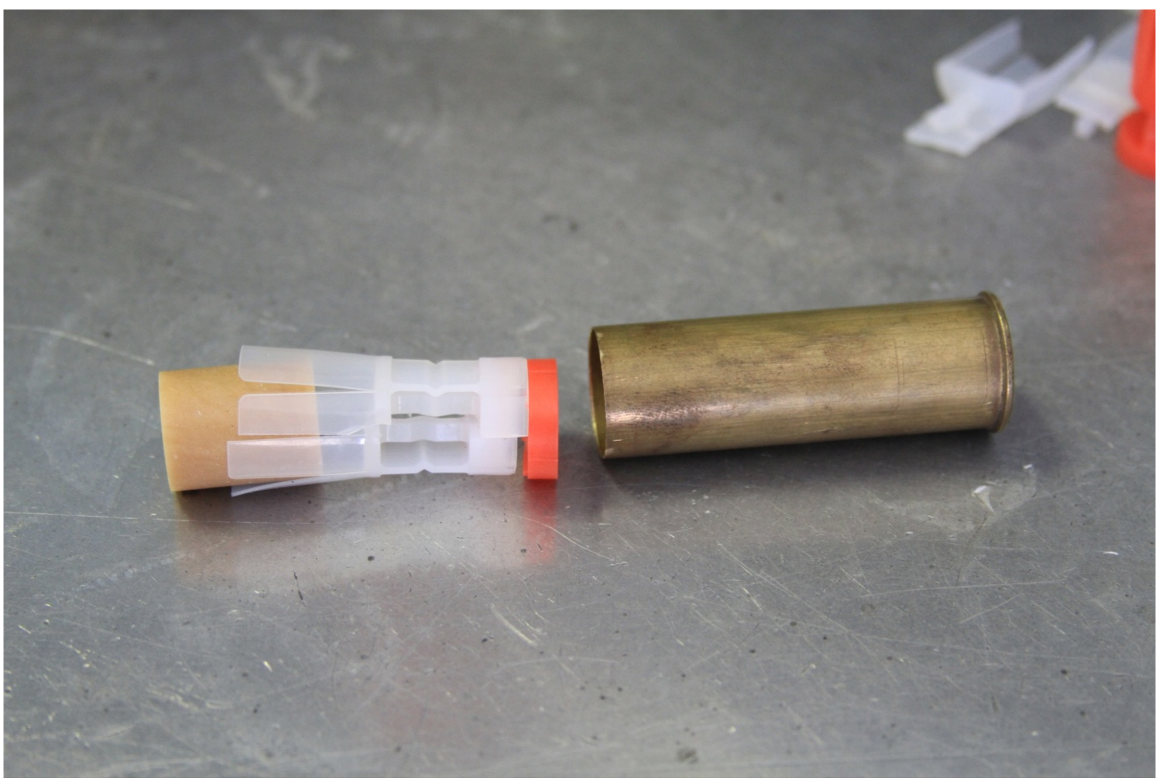

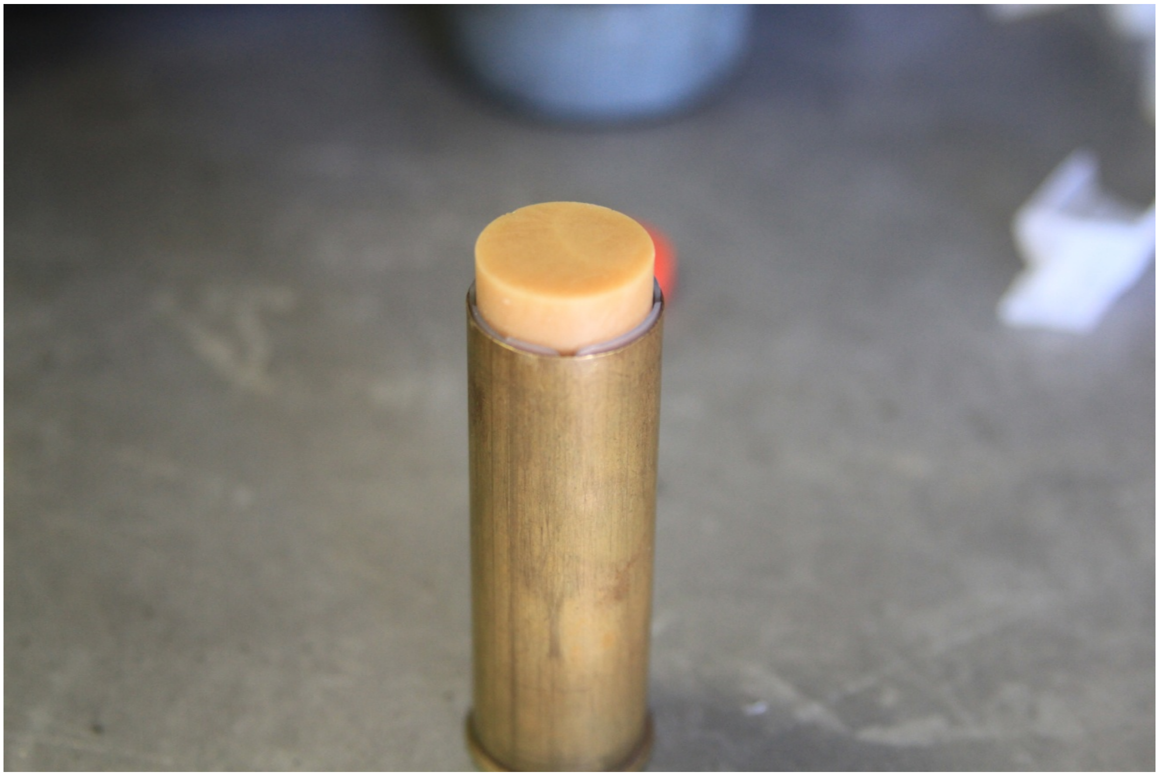

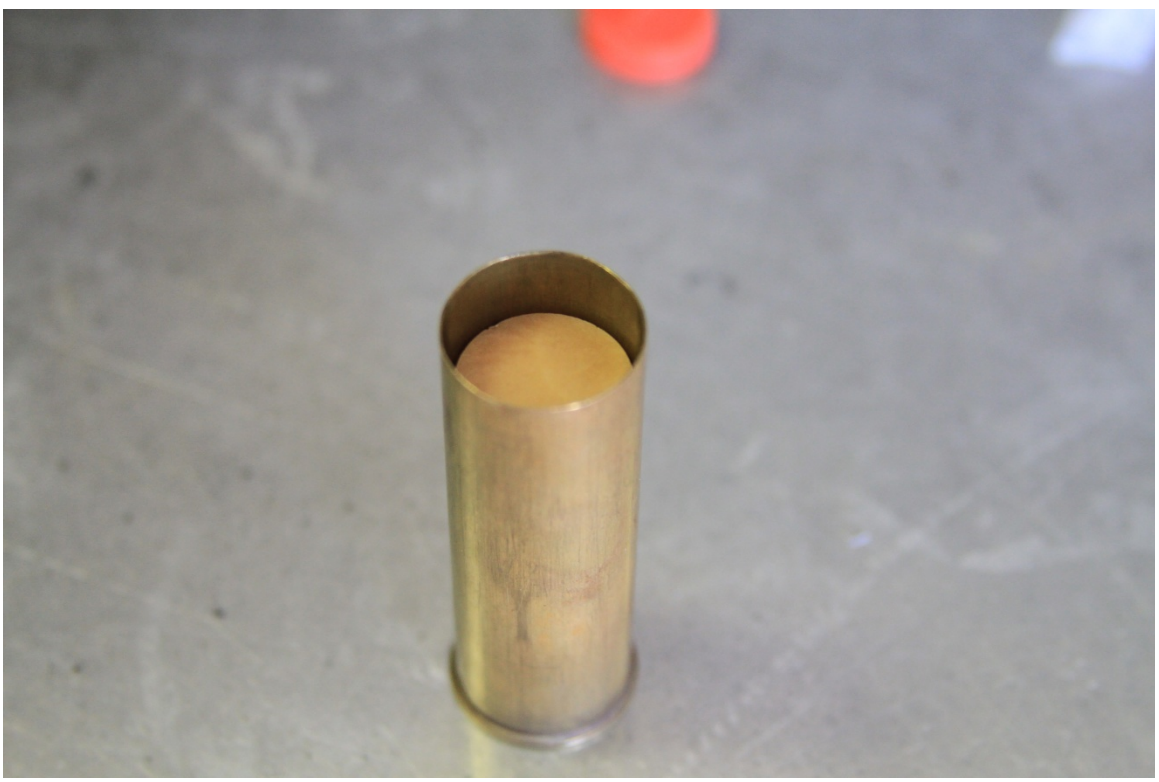

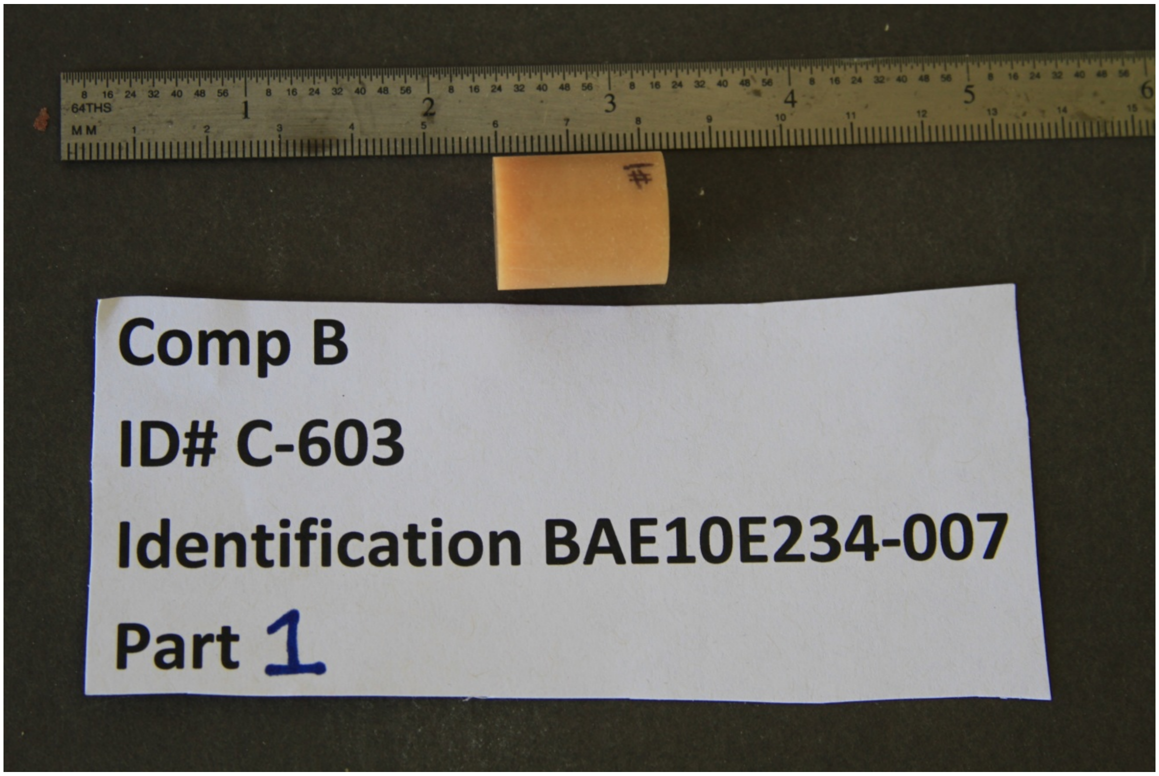
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Part 1


Comp B
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Part 2


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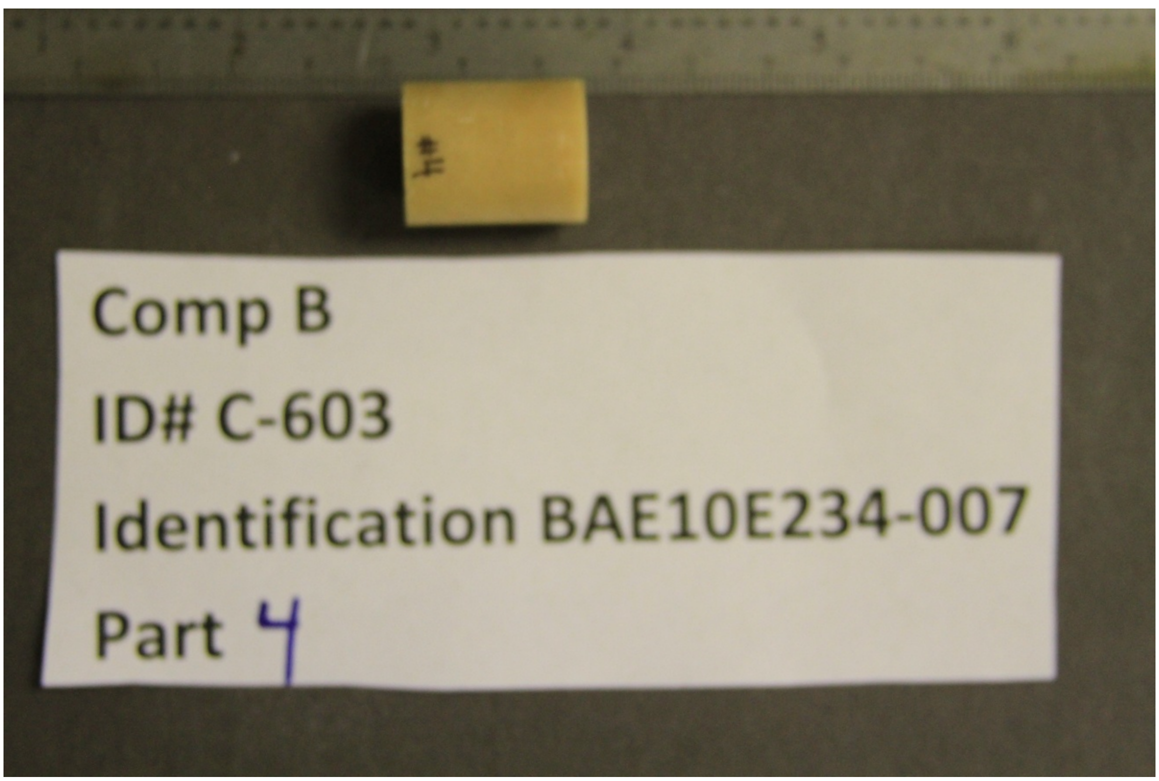
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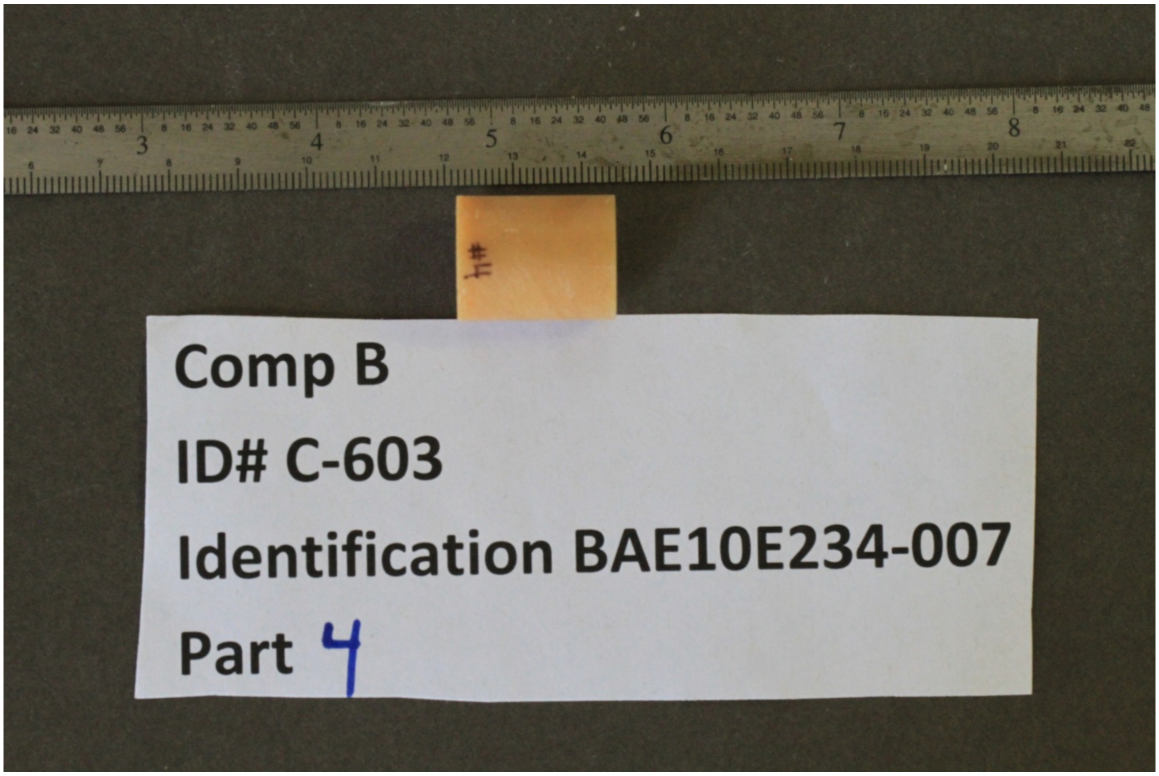

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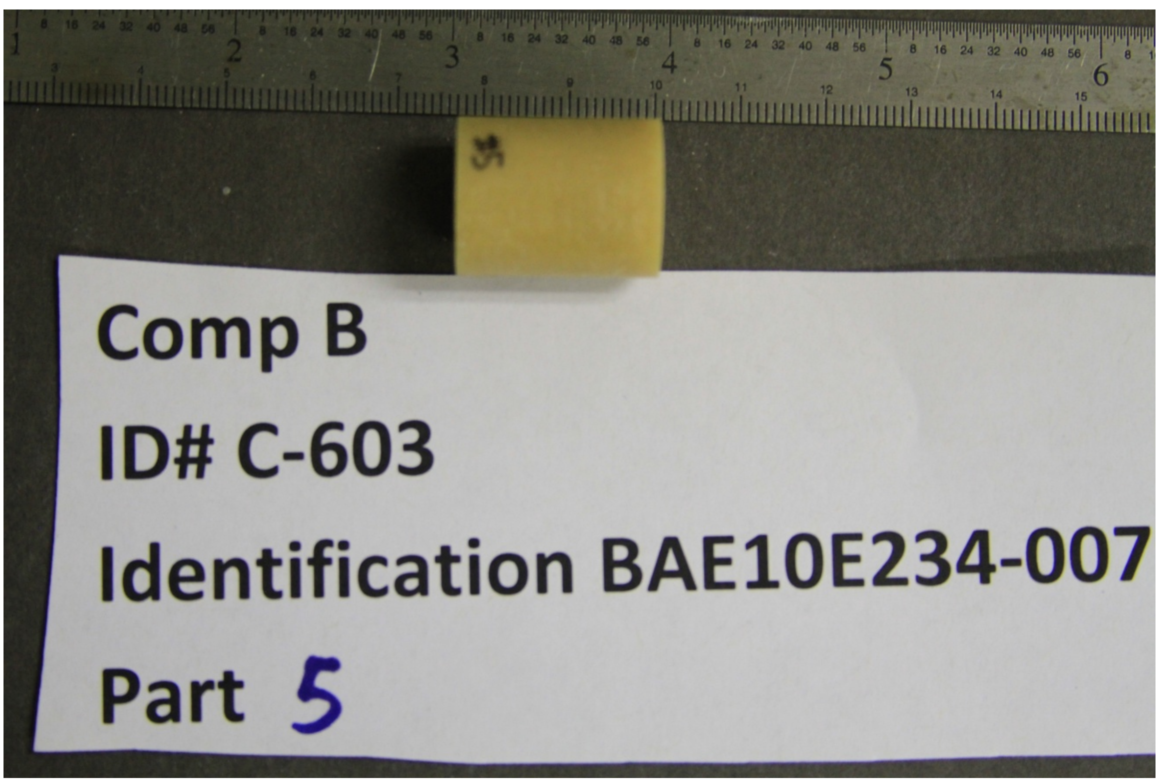

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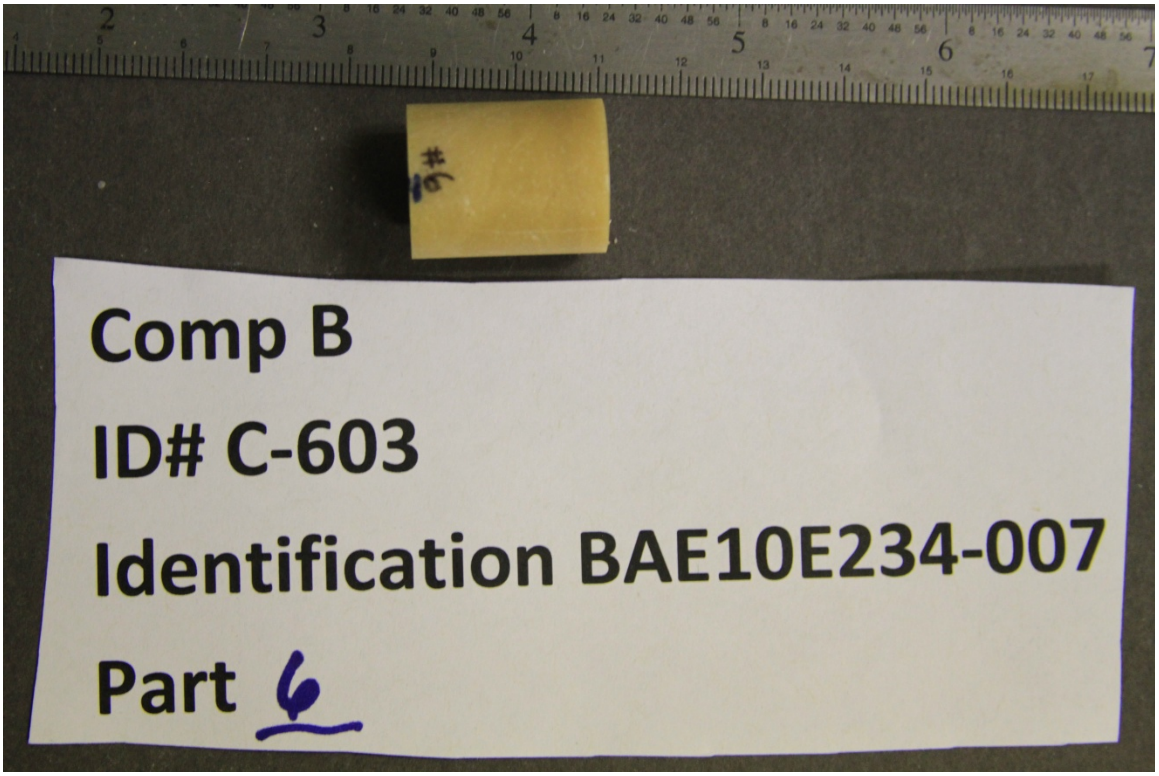
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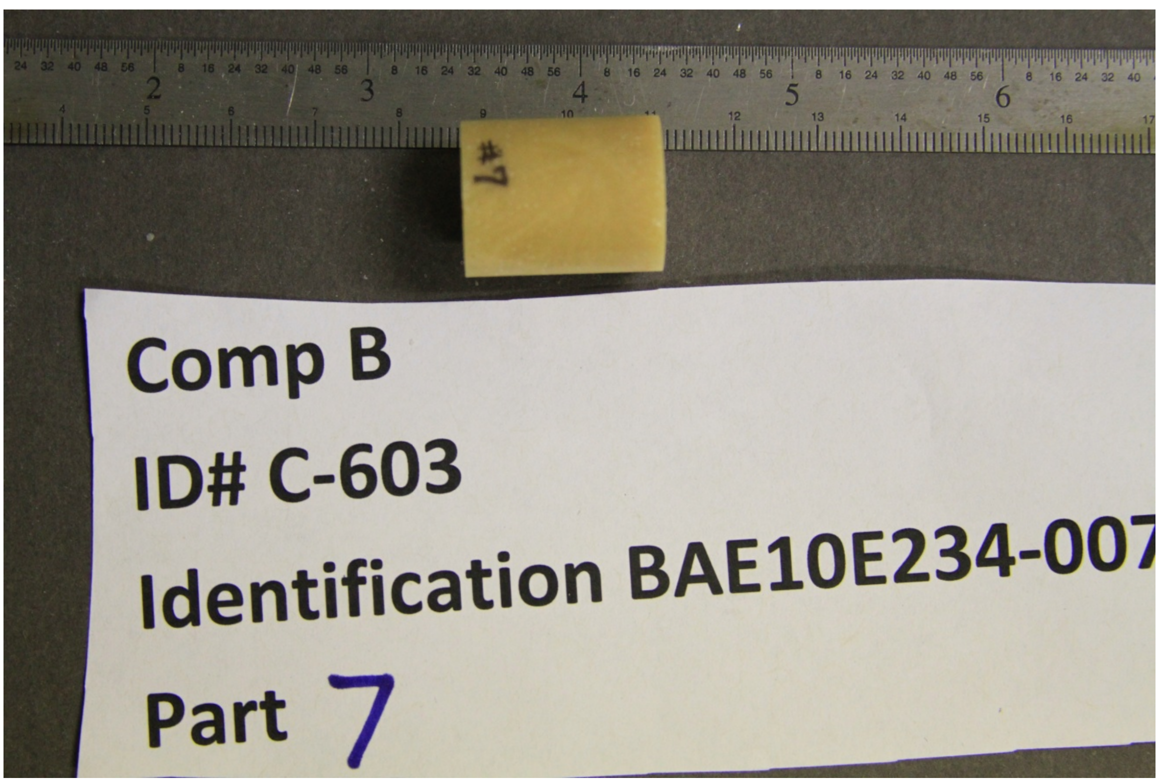
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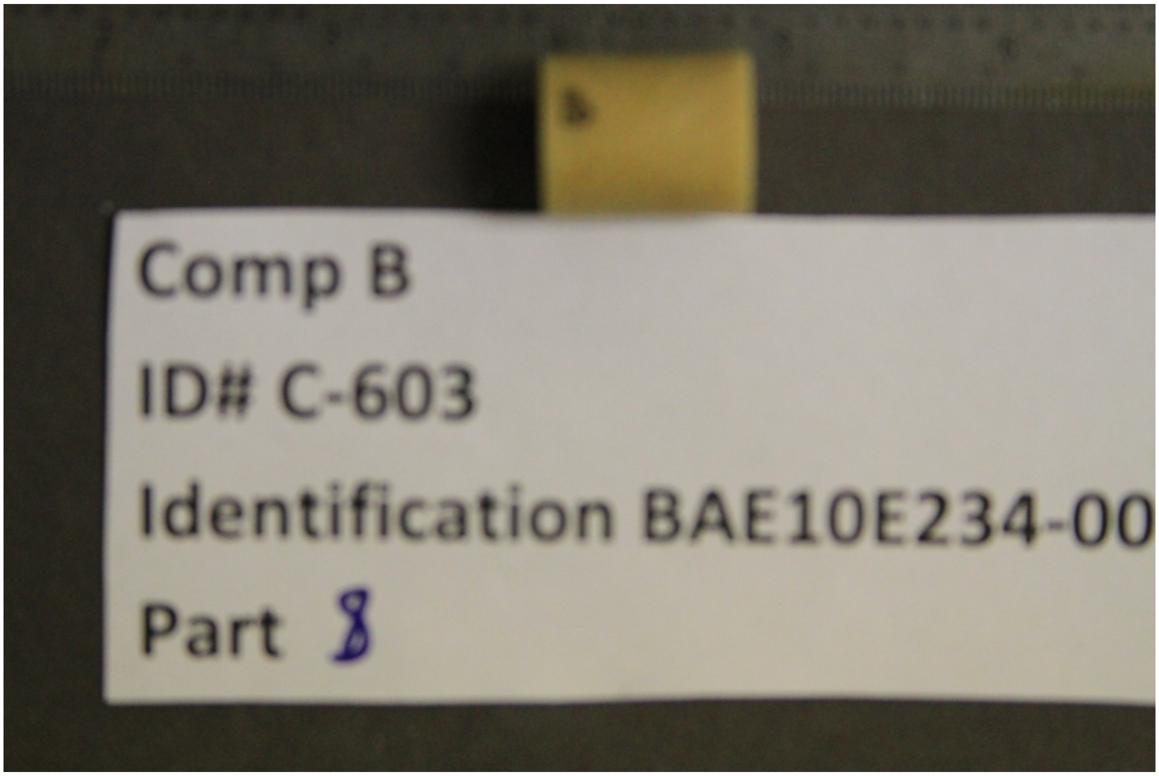
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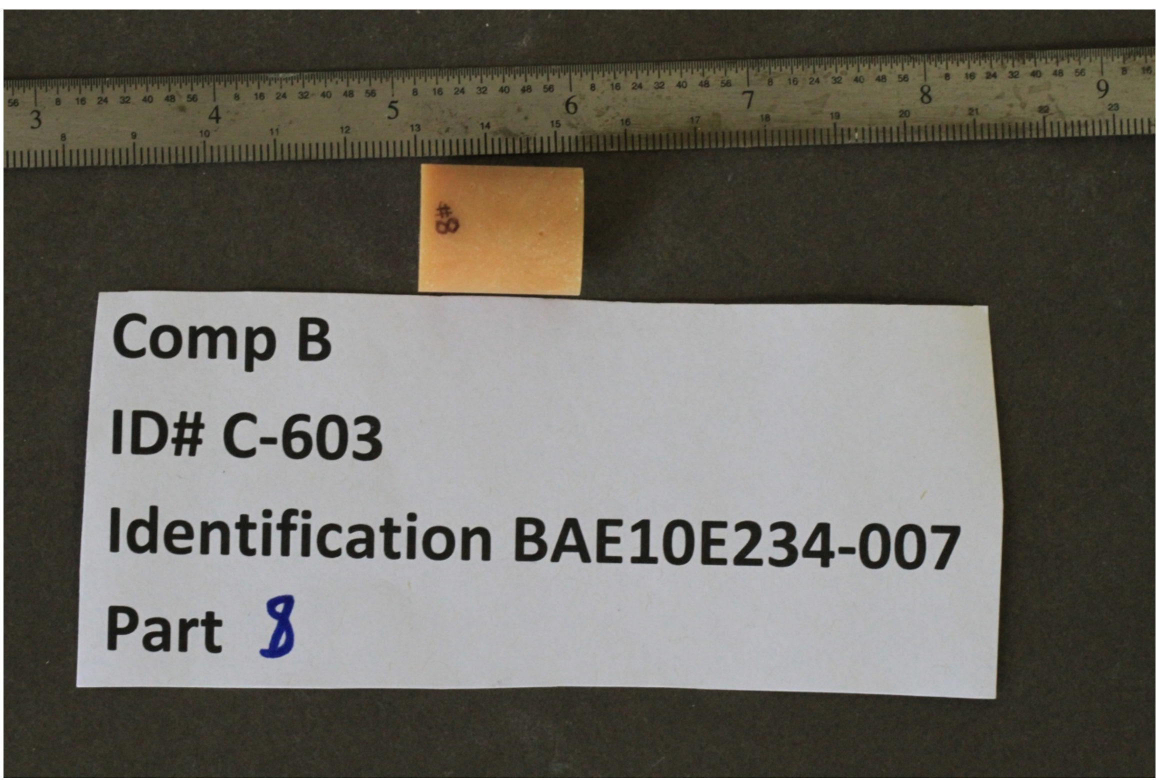
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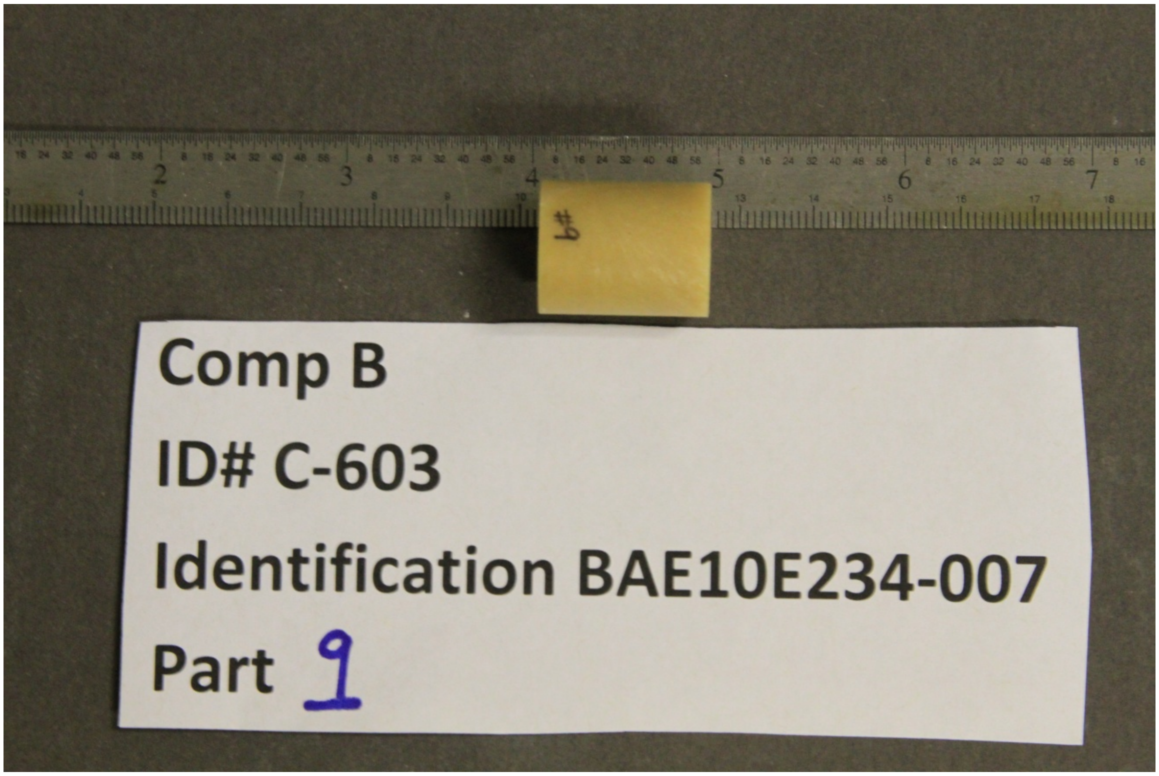
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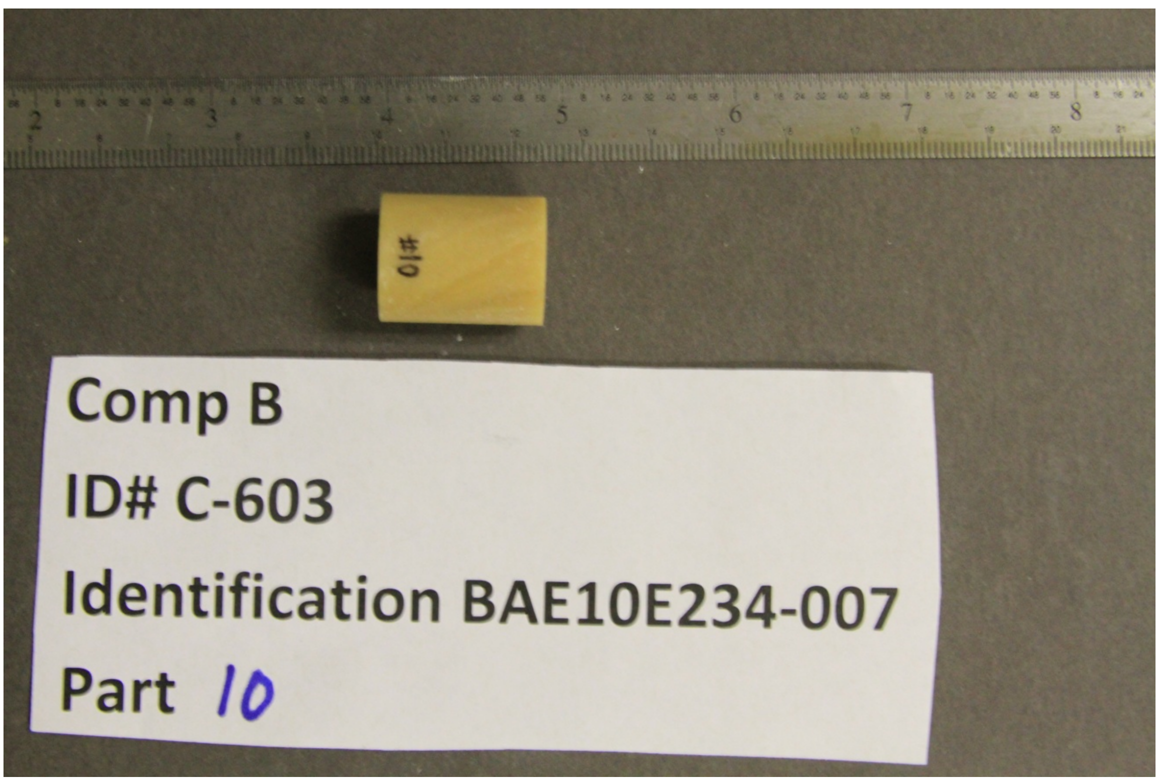
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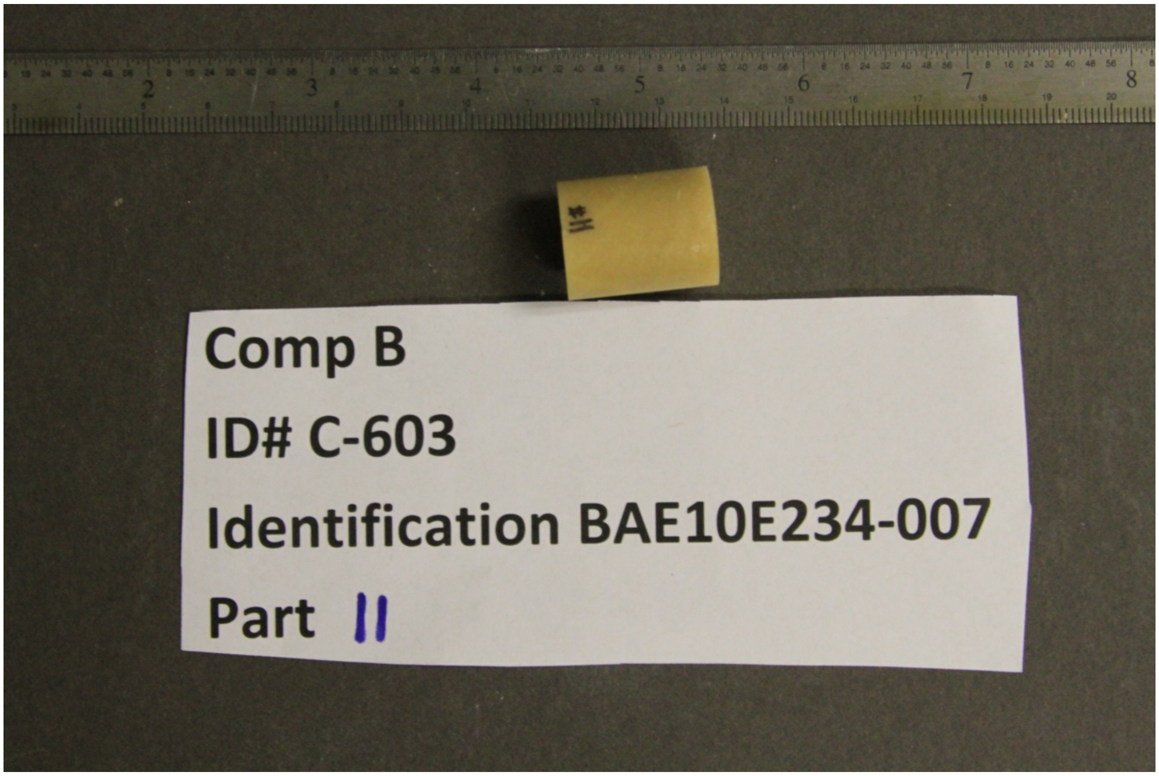
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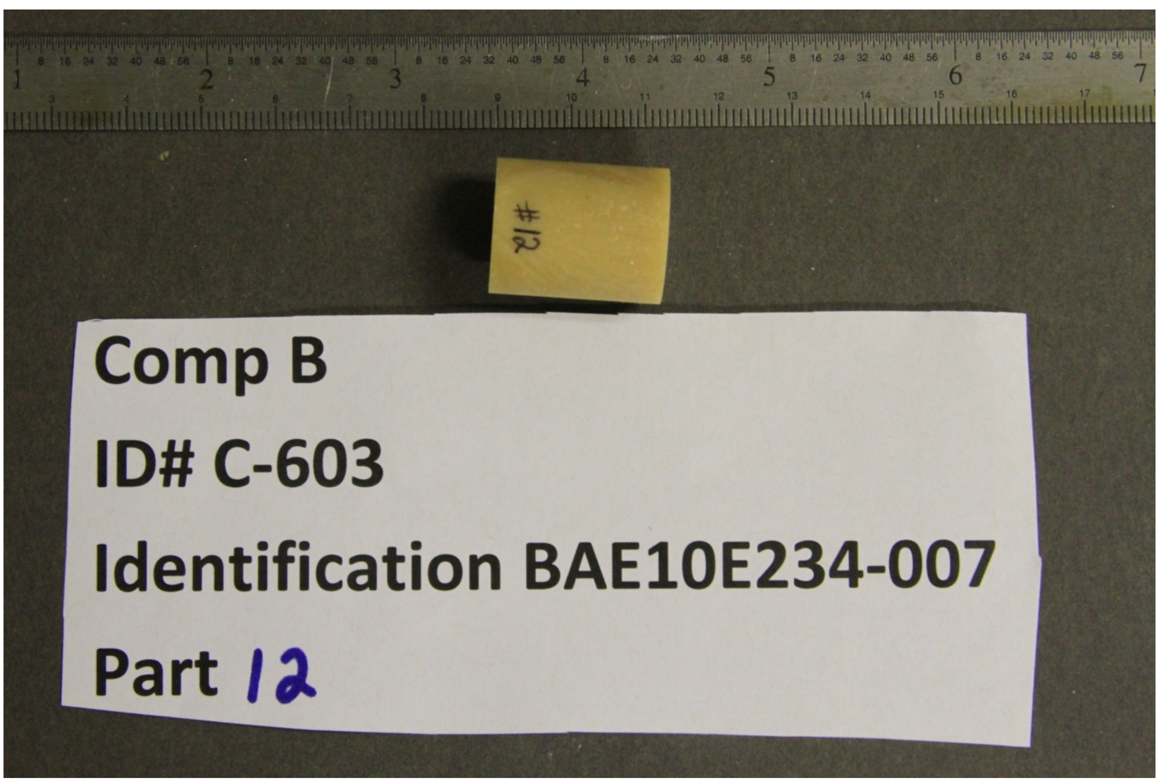
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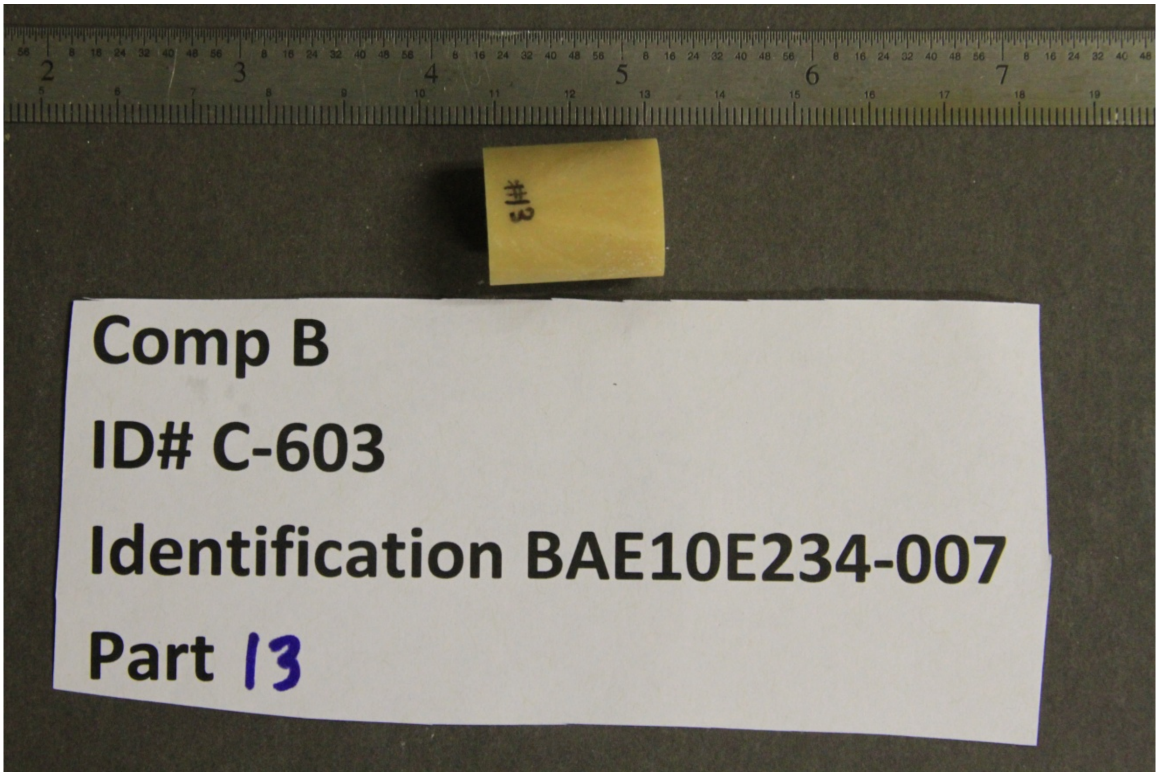
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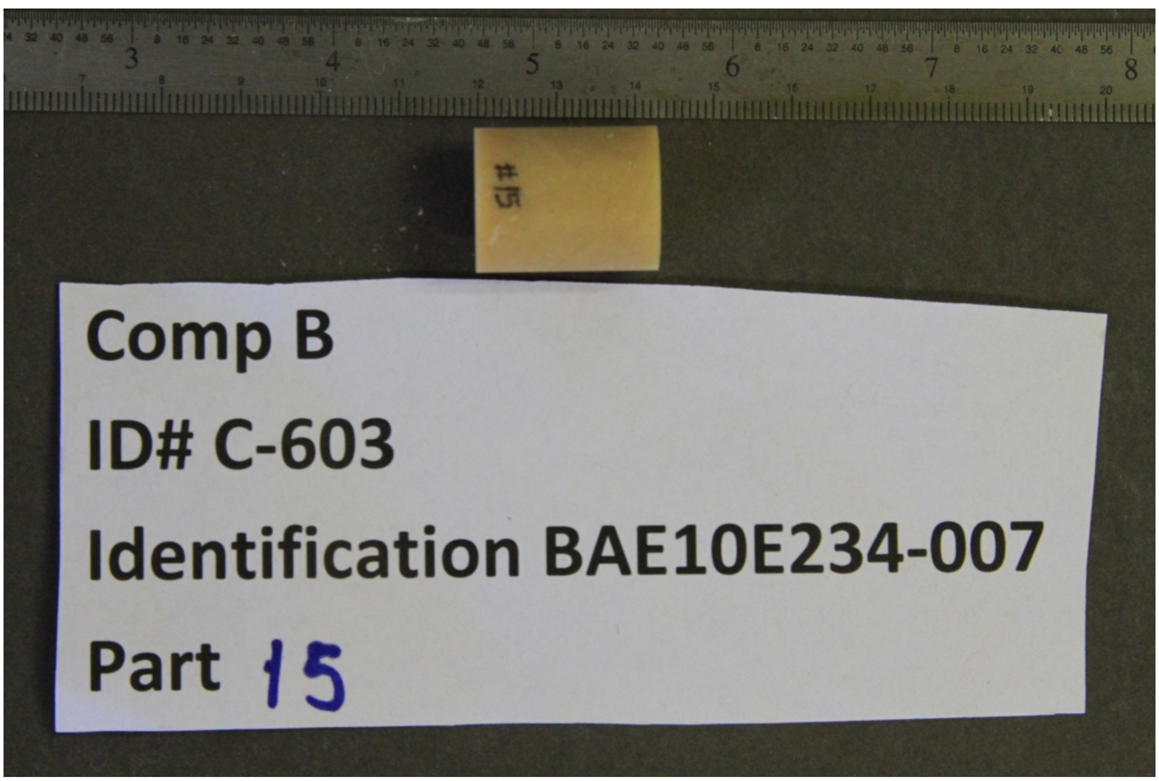
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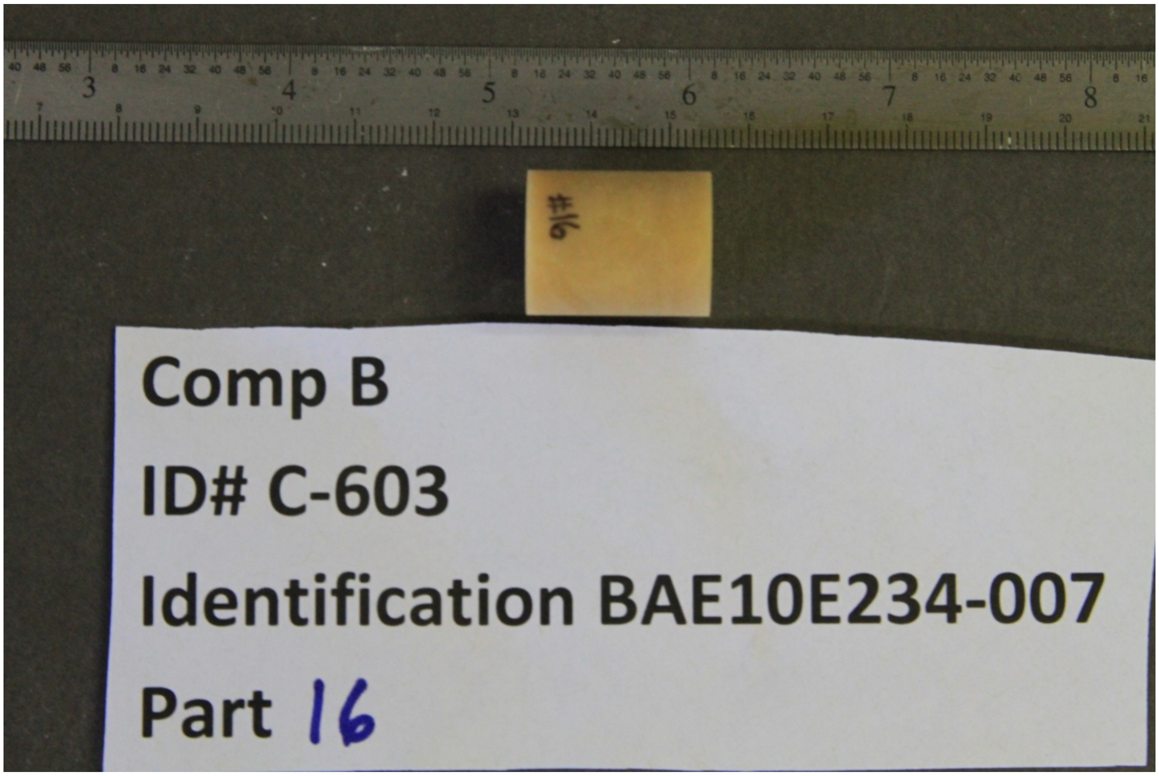
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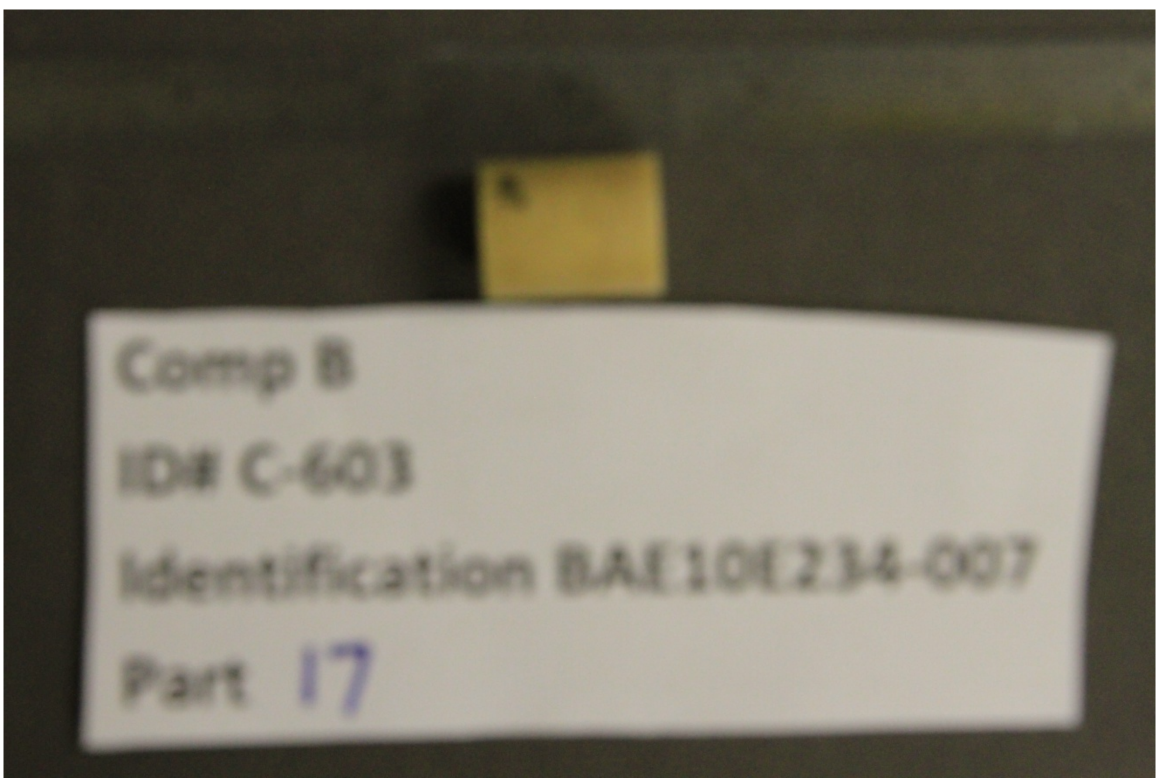
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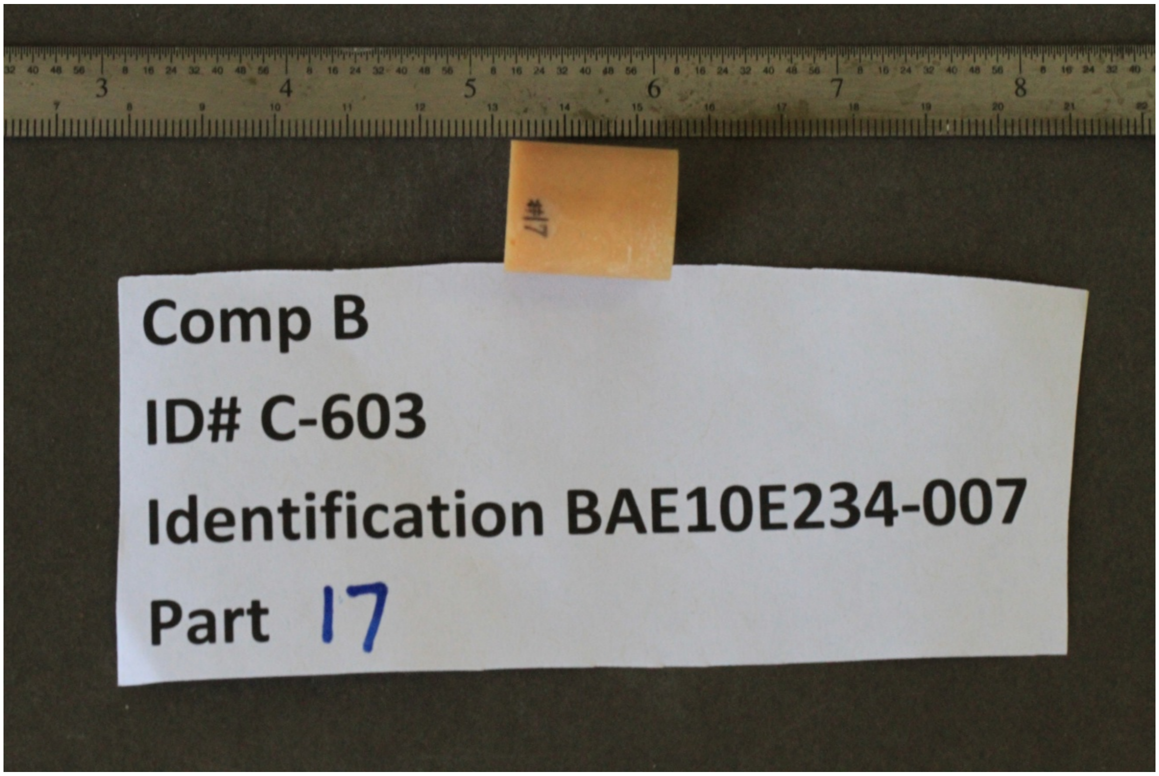
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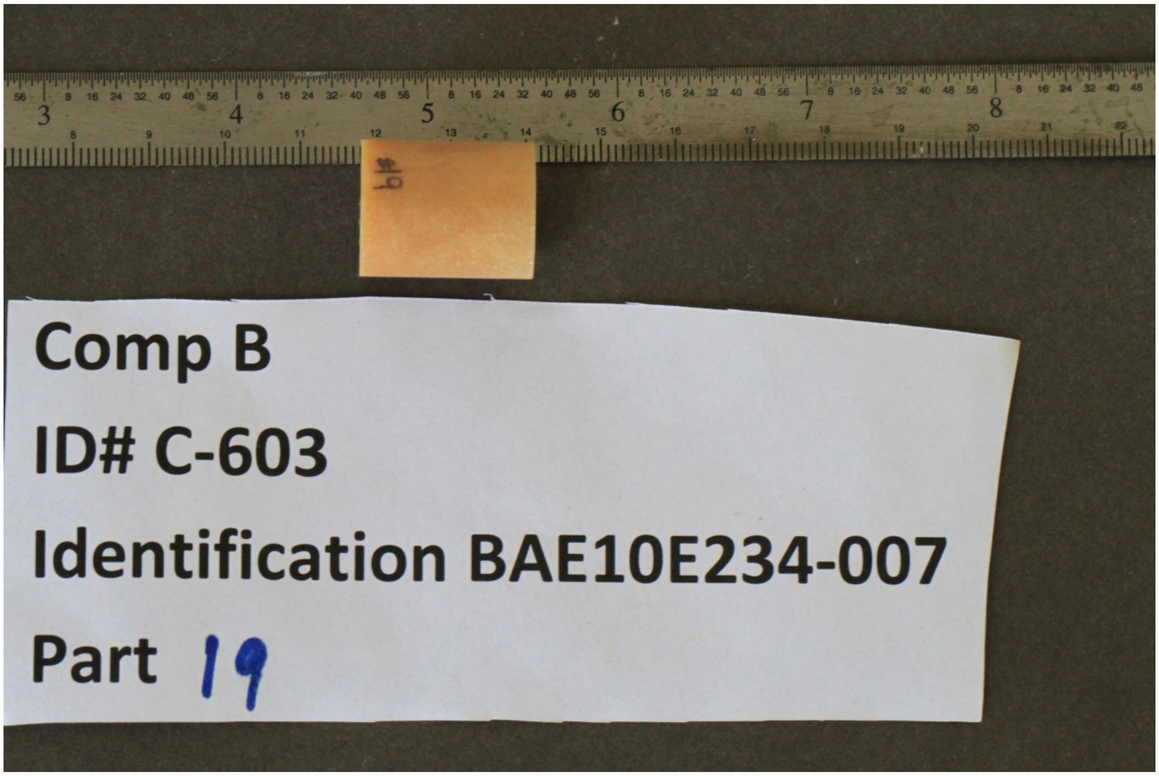
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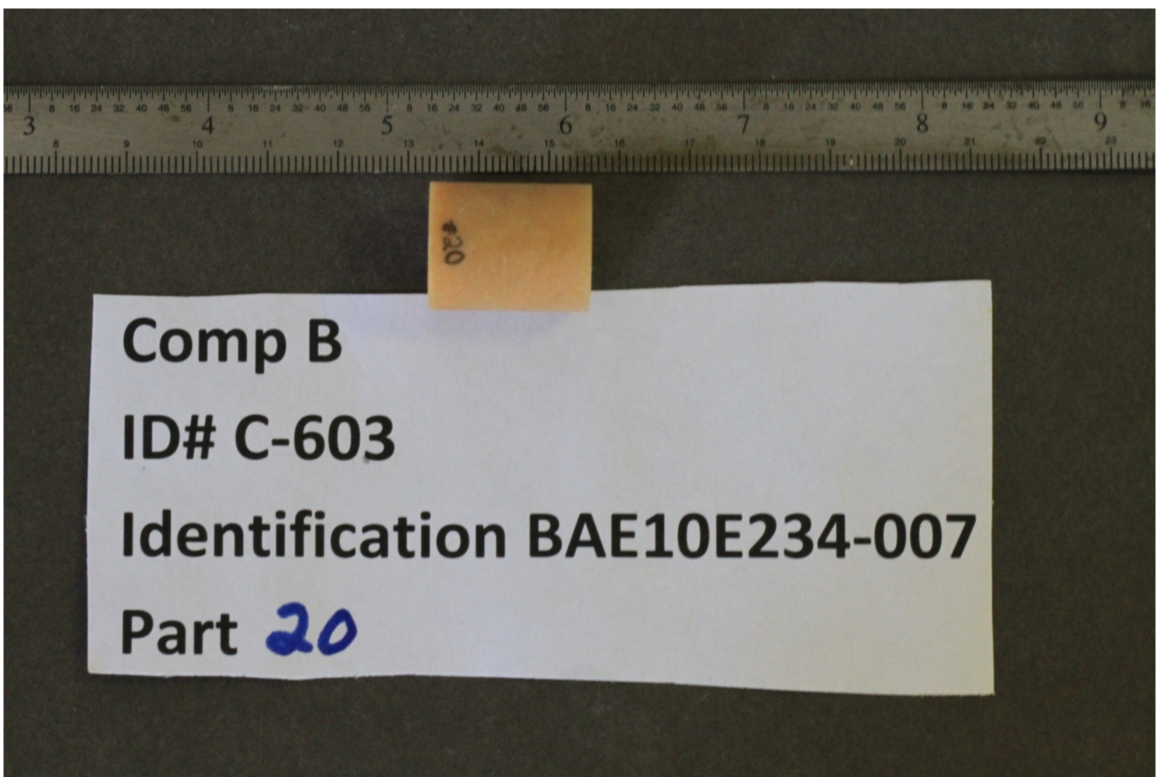
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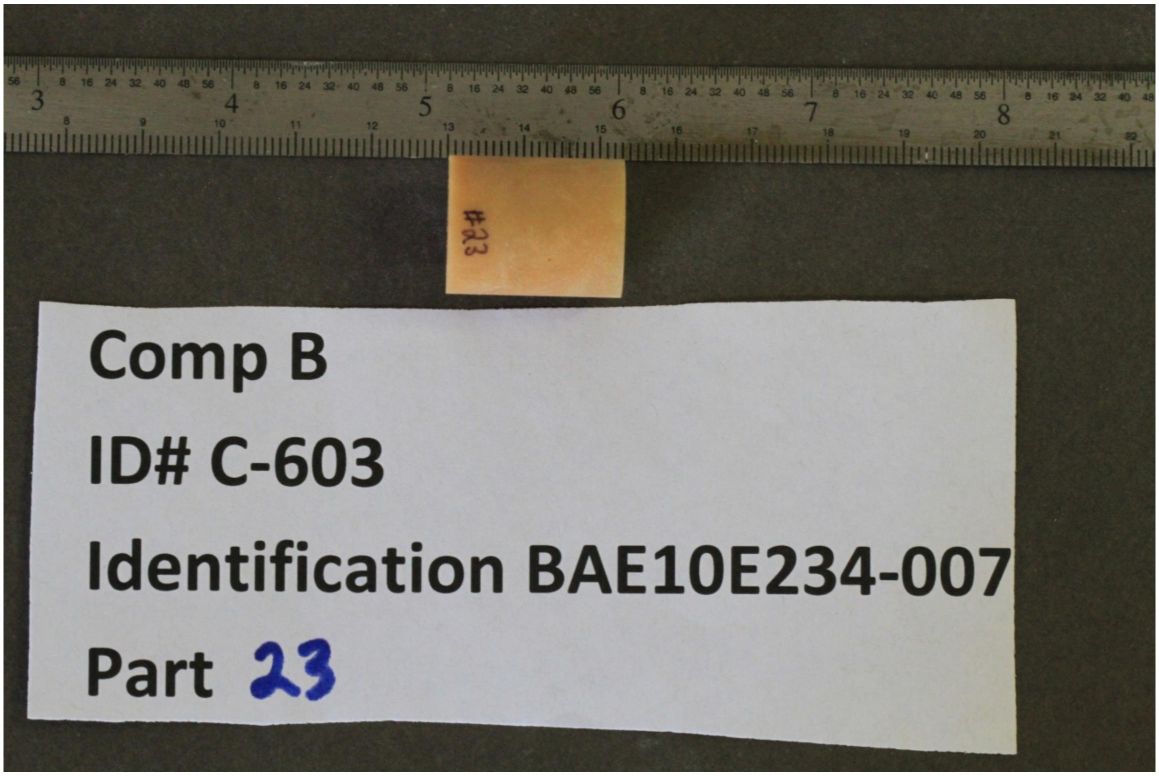
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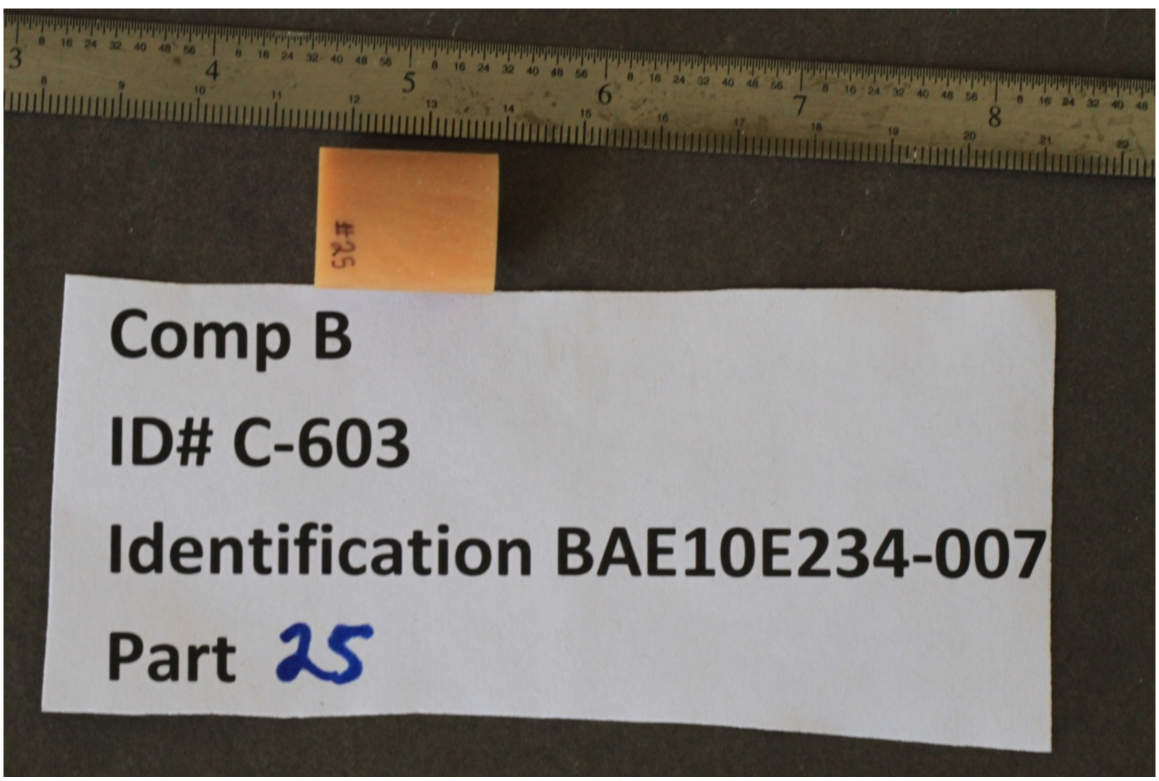
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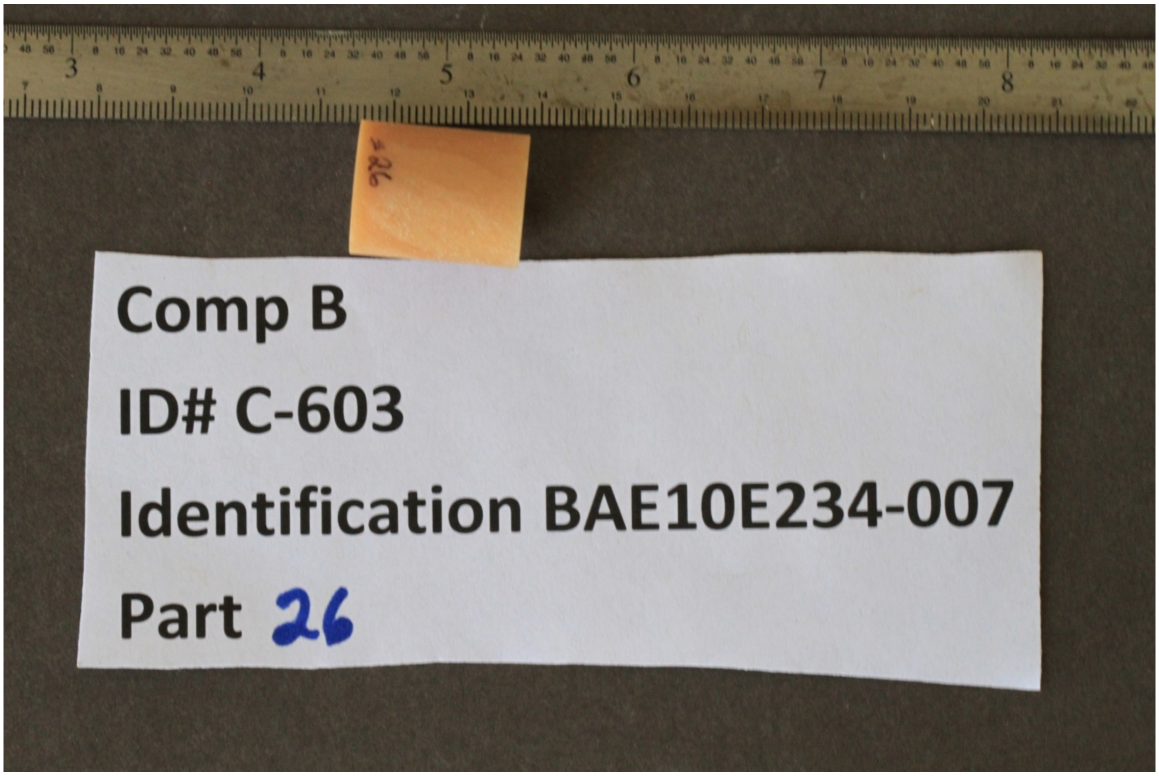
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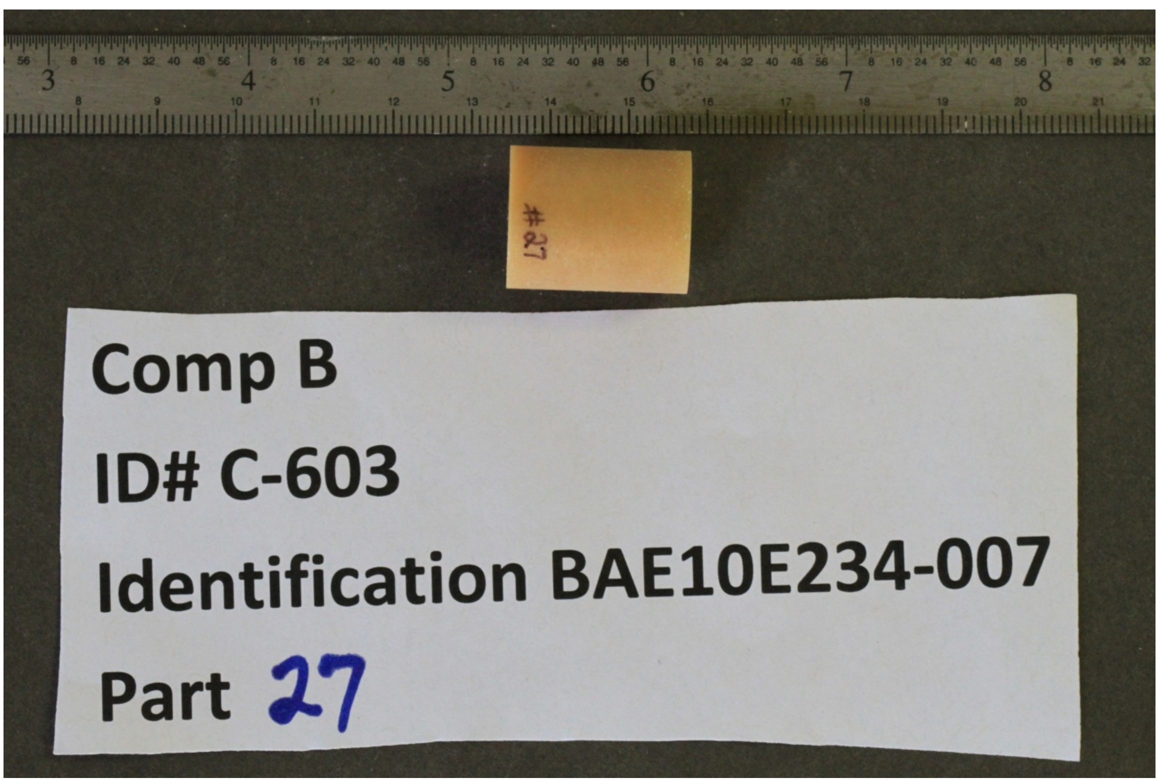
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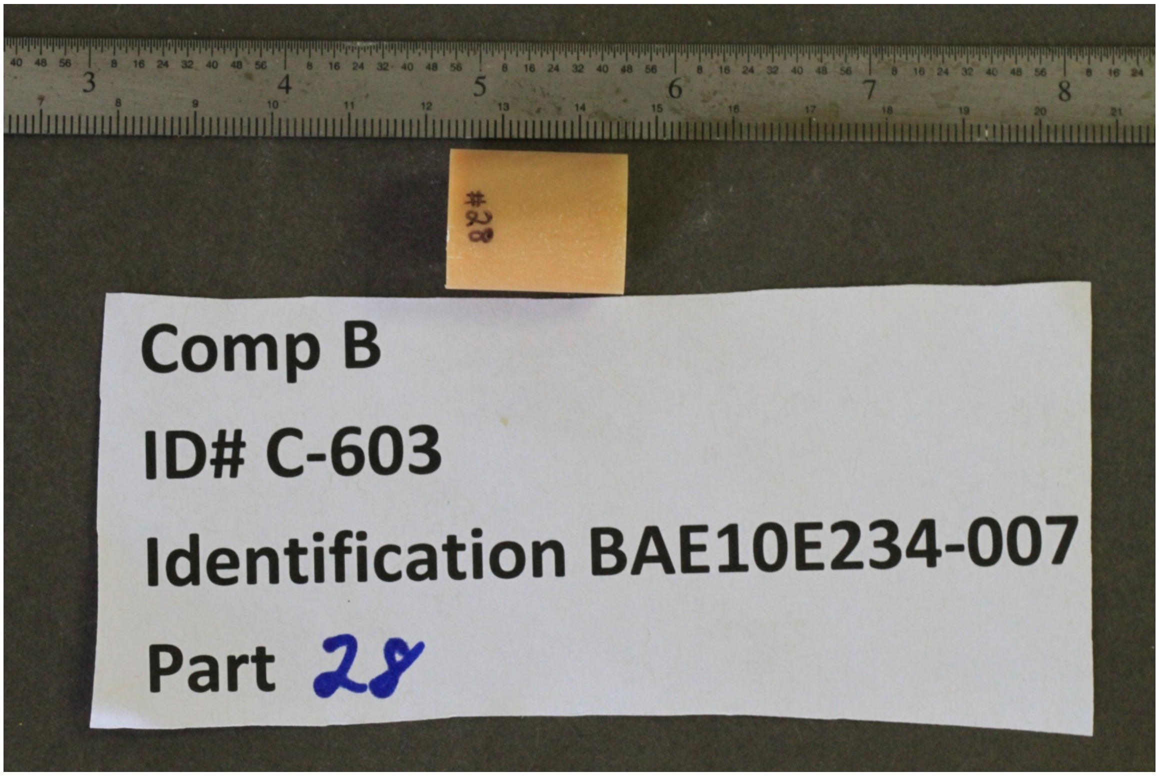
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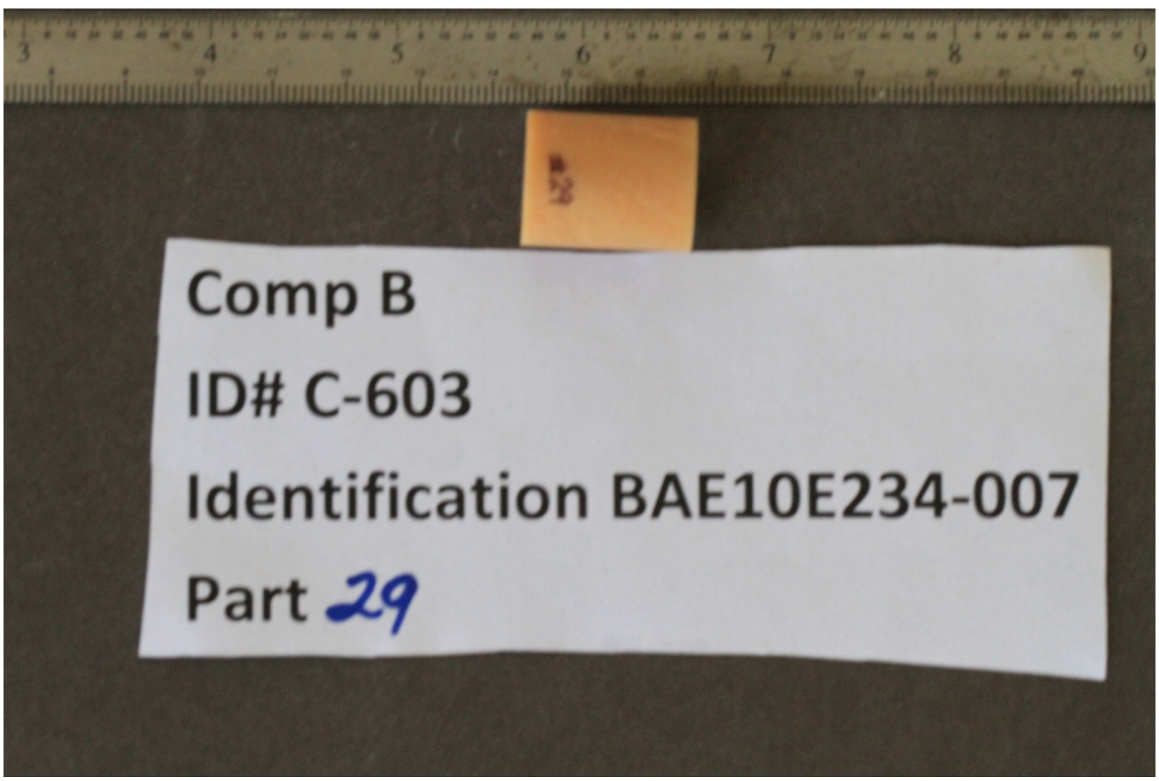
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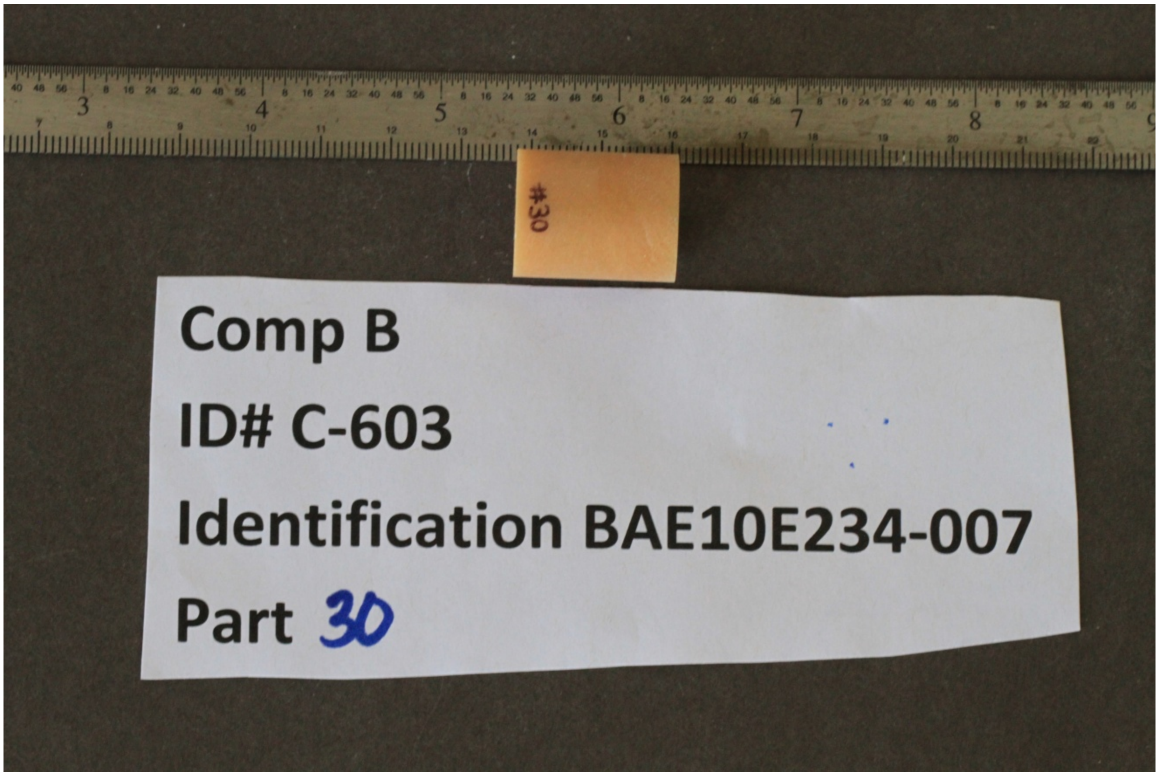
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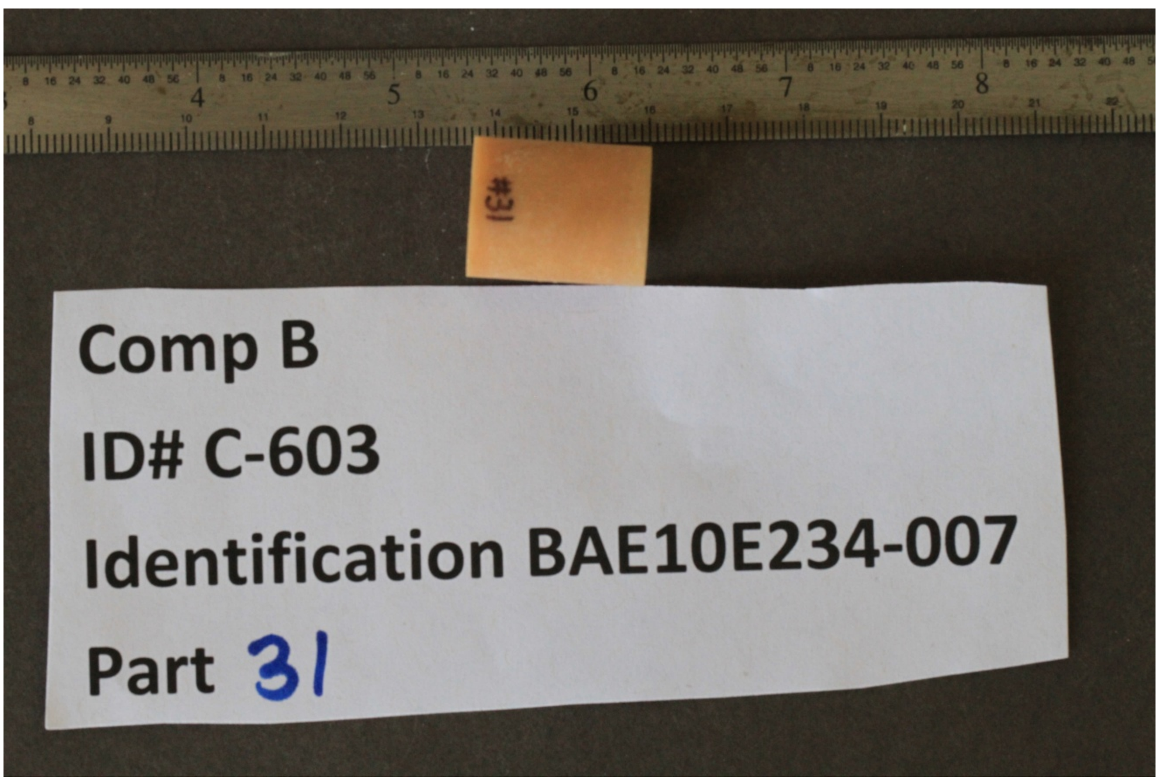
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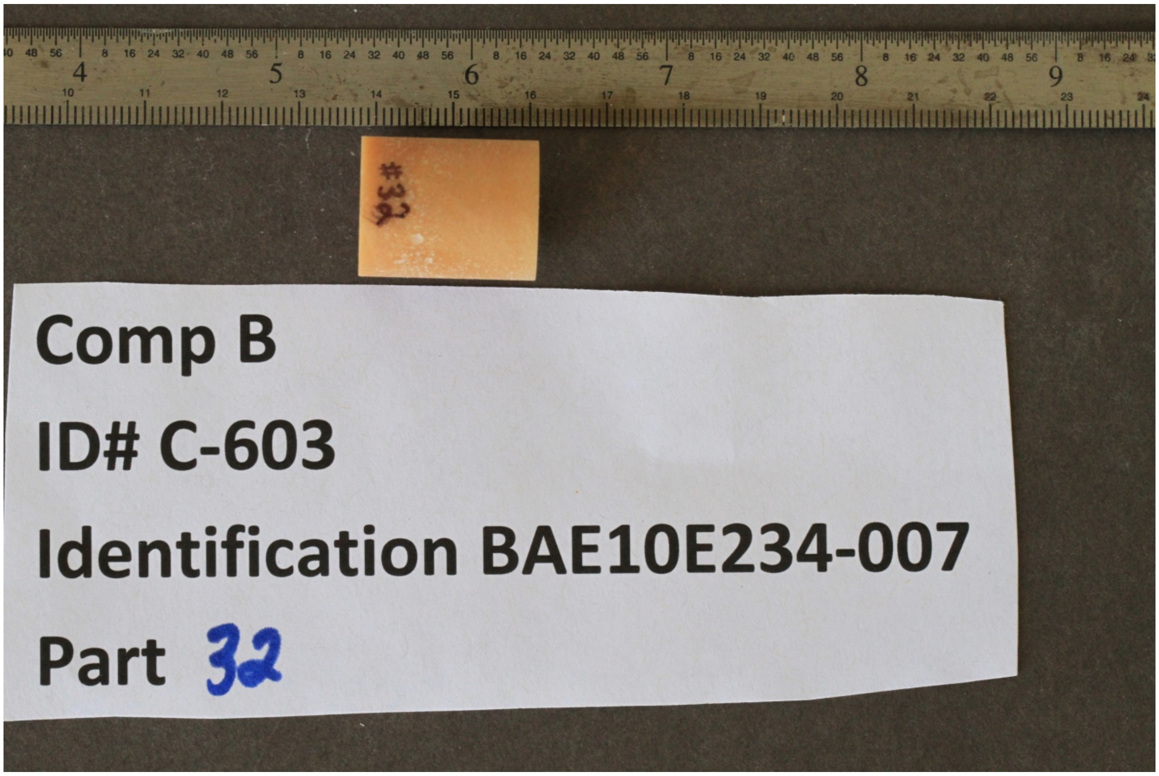
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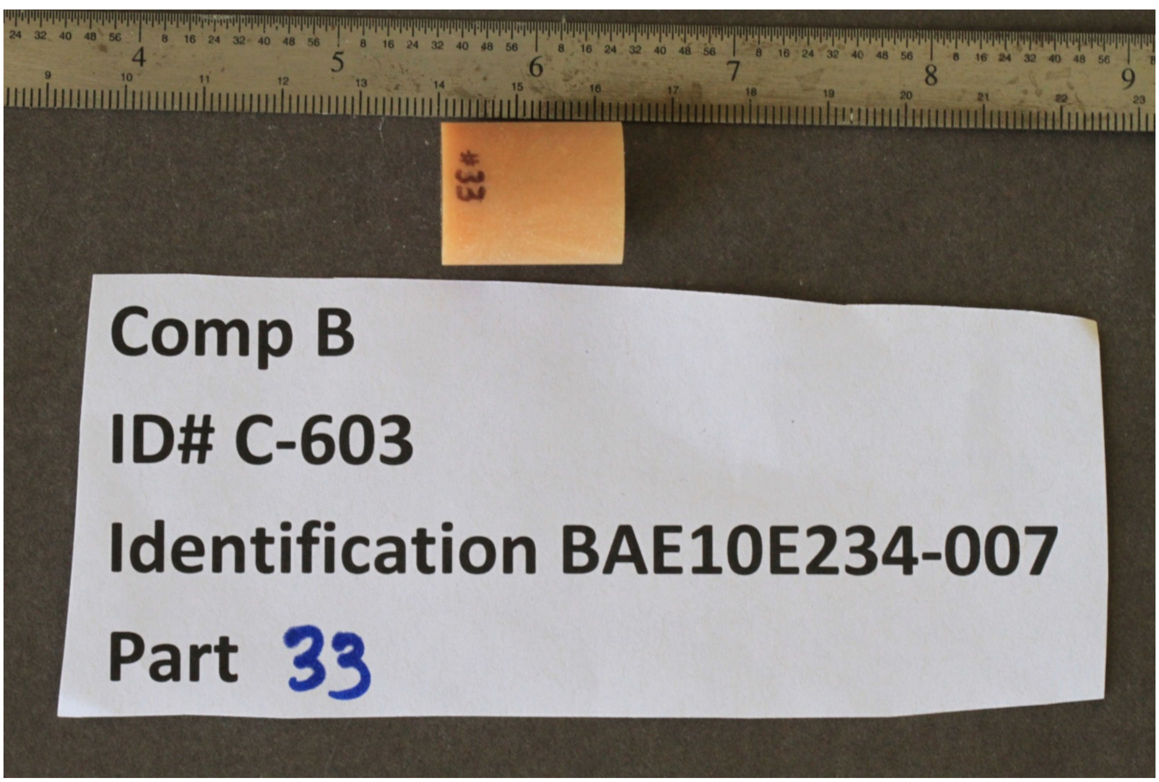
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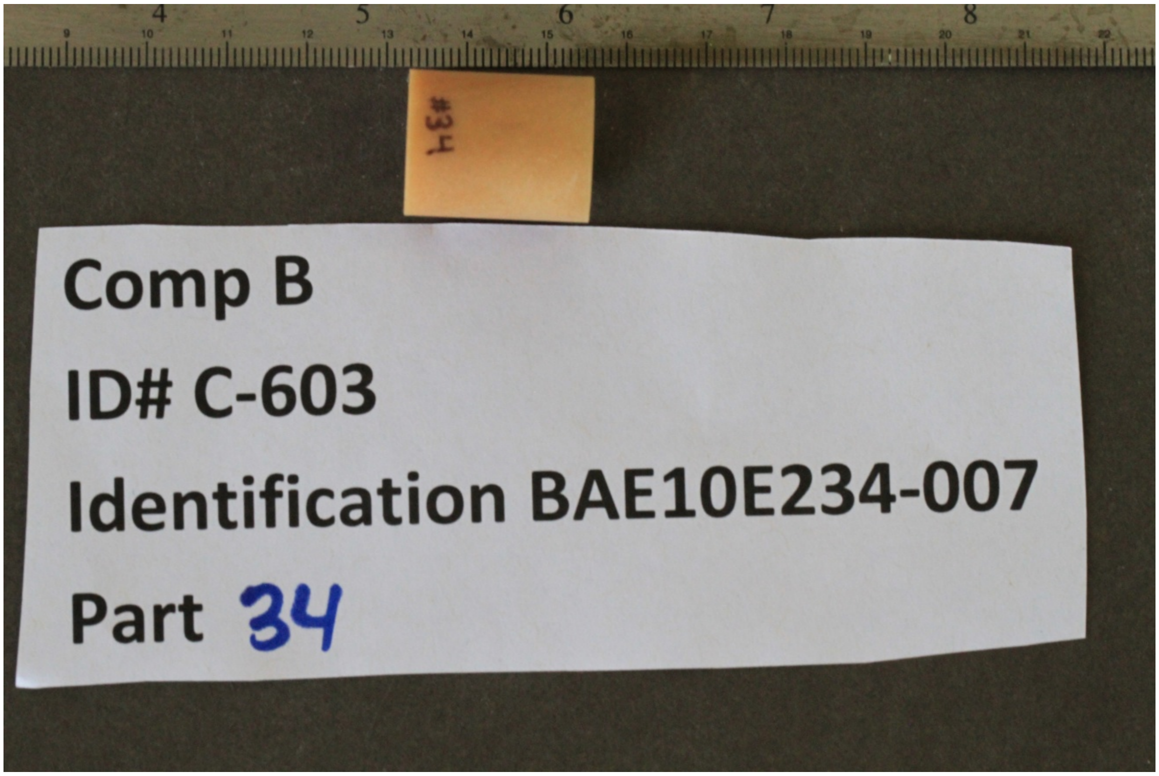
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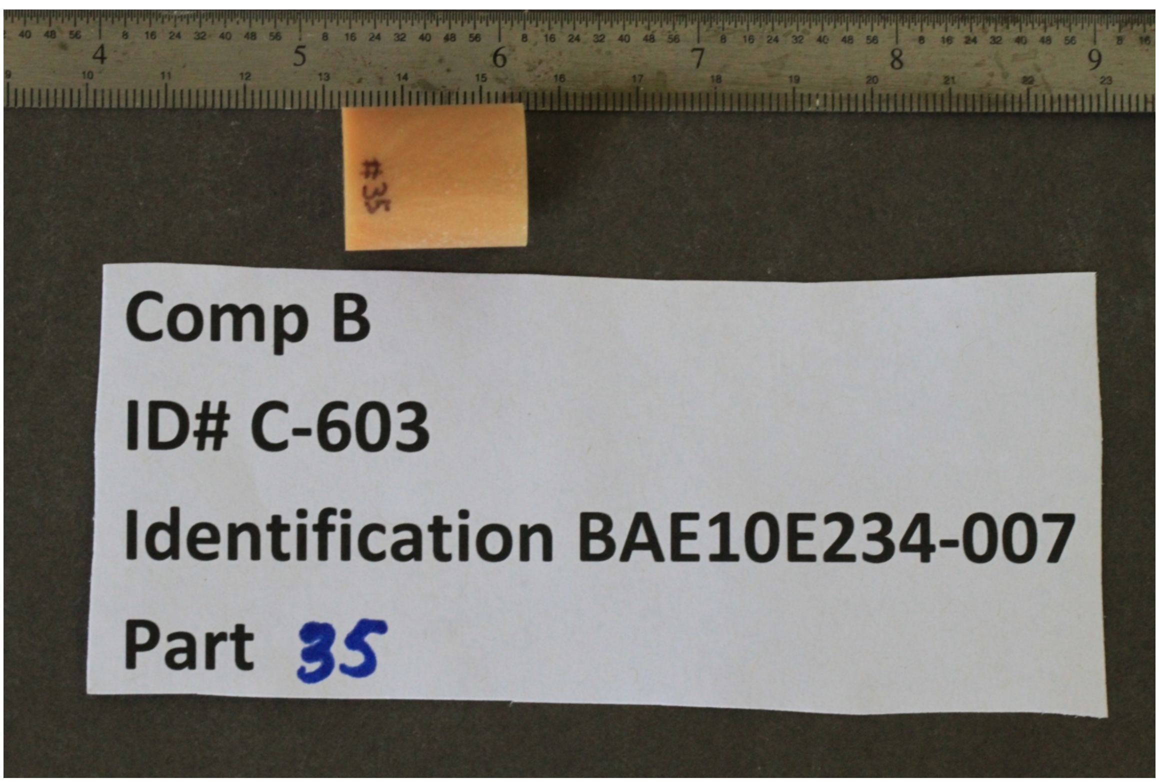
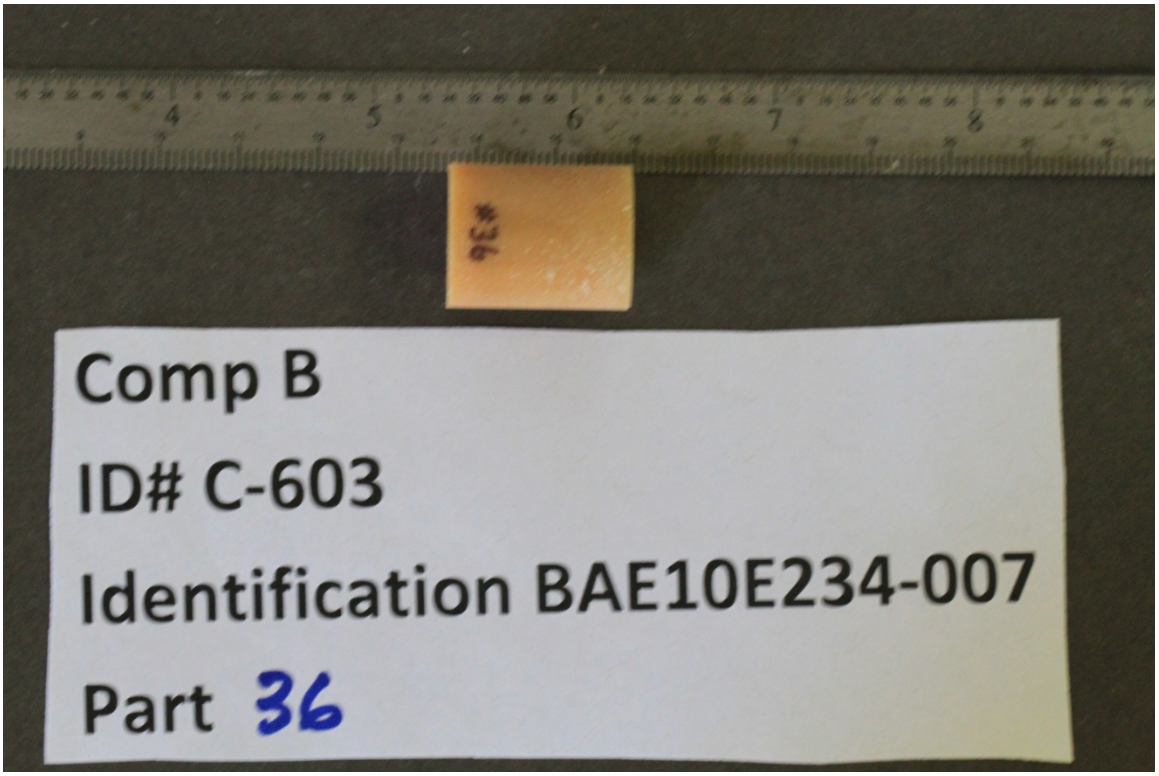
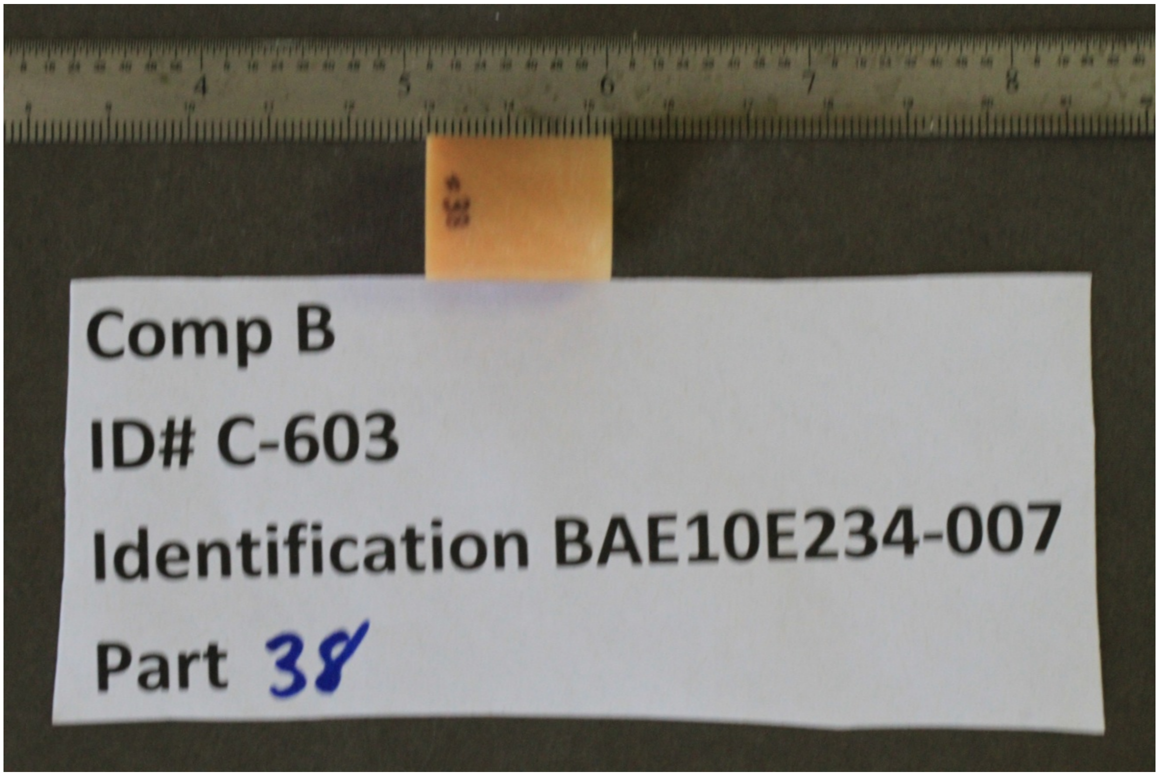
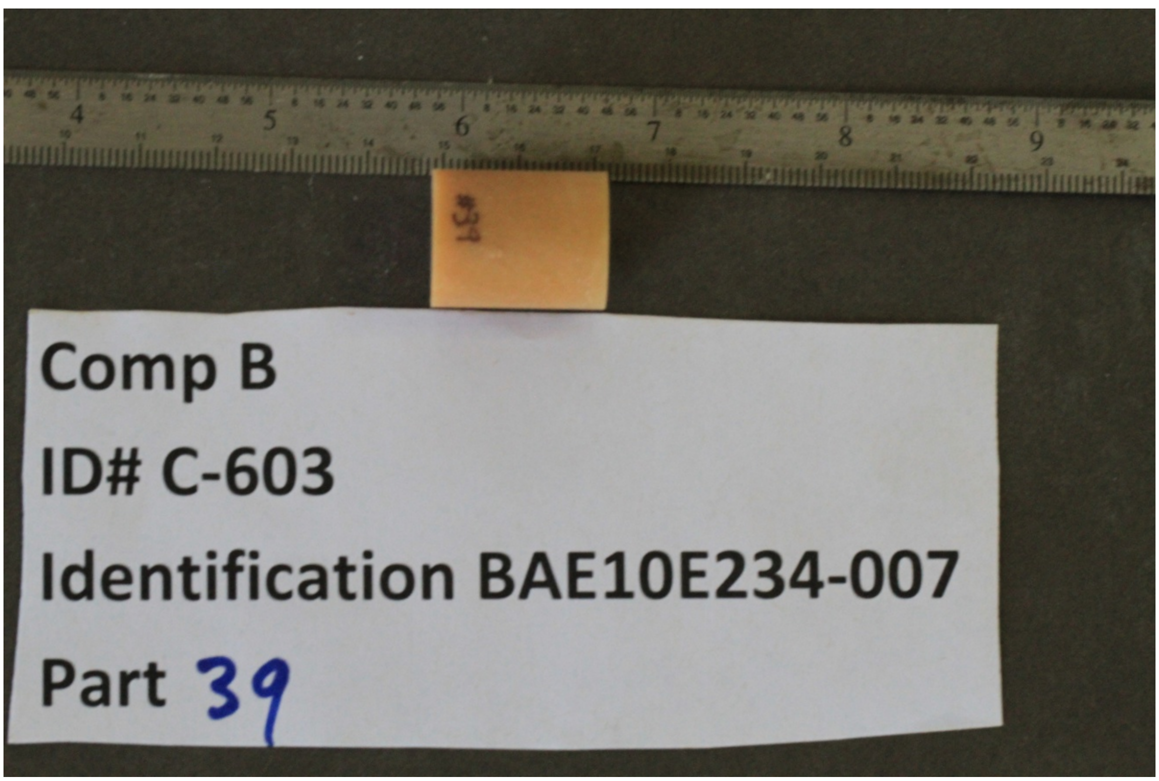
Identification BAE10E234-007
Part 34

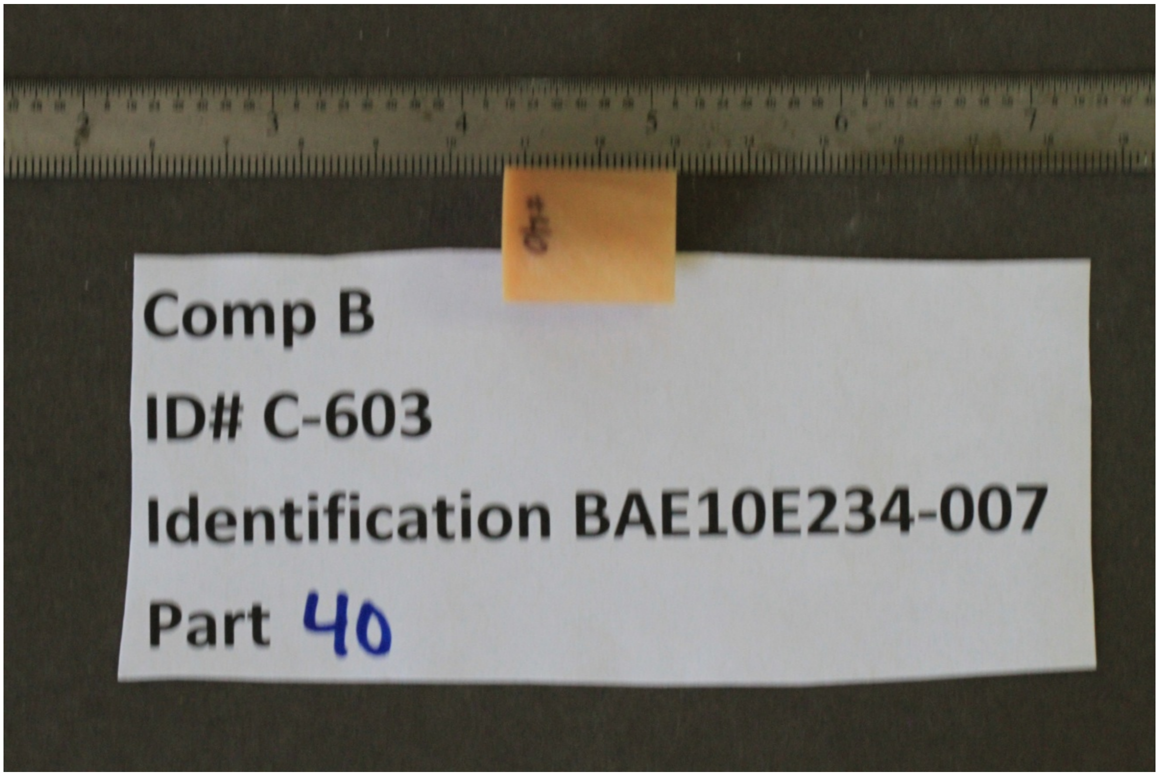

#35
Comp B
ID# C-603
Identification BAE10E234-007
Part 35


#36
Comp B
ID# C-603
Identification BAE10E234-007
Part 36


#37
Comp B
ID# C-603
Identification BAE10E234-007
Part 37


Comp B
ID# C-603
Identification BAE10E234-007
Part 38


Comp B
ID# C-603
Identification BAE10E234-007
Part 39


Comp B
ID# C-603
Identification BAE10E234-007
Part 40

Appendix B

PHOTOGRAPHS AND TABULAR DATA FOR SPHERES

(The contents of this appendix are reproduced in facsimile.)

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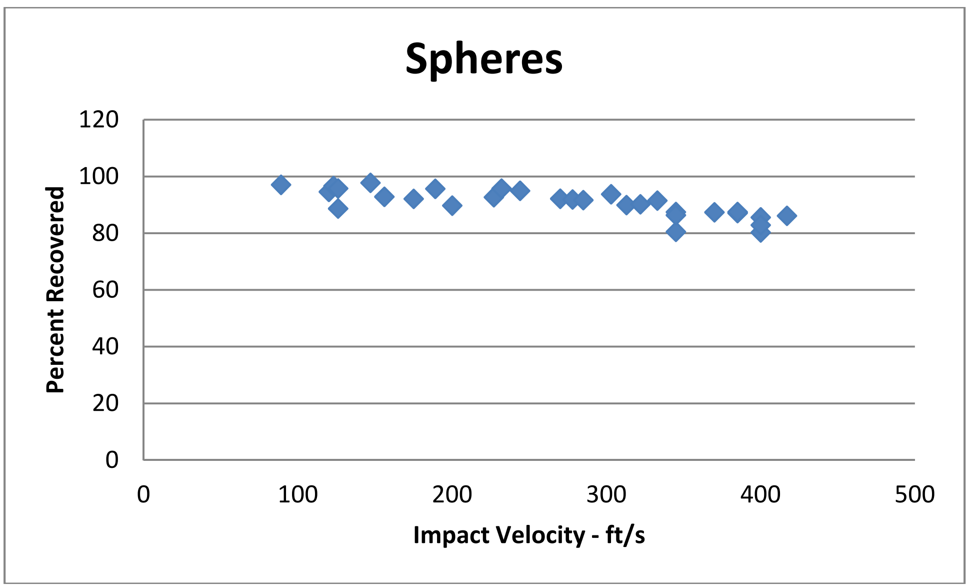
Part #	Diameter(mm)	Weight	Pressure	Velocity	Rec. Weight	Percent	Comments5
	(mm)	(gm)	(psi)	(ft/sec)	(gm)	Recovered	
1	18.00	5.2691	40	147	5.1504	97.74724	
2	17.99	5.2694	25	89	5.1141	97.0528	Hit Catch box
3	18.00	5.2634	25	120	4.9779	94.57575	Shear/Clip
4	17.99	5.2635	25	126	4.6676	88.67864	Hit outside catch box
5	18.01	5.2658	30	123	5.0883	96.62919	
6	17.99	5.2655	30	156	4.8878	92.82689	clipped
7	18.00	5.2680	30	175	4.8518	92.09947	
8	18.01	5.2520	50	270	4.8395	92.1458	
9	18.01	5.2628	52	278	4.8349	91.8693	
10	18.00	5.2572	100	400	4.4991	85.5798	
11	18.00	5.2609	100	417	4.5305	86.1164	
12	18.00	5.2673	75	313	4.7363	89.9189	
13	17.99	5.2700	75	345	4.2423	80.4991	
14	18.00	5.2684	75	345	4.6073	87.4516	
15	18.00	5.2647	40	227	4.8798	92.6890	
16	18.00	5.2599	25	126	5.0368	95.7585	
17	18.00	5.2386	35	200	4.6999	89.7167	holes in it
18	18.00	5.2656	35	189	5.0364	95.6472	
19	18.00	5.2634	85	345	4.5454	86.3586	
20	17.99	5.2594	90	333	4.8111	91.4762	
21	18.00	5.2549	95	370	4.5912	87.3699	
22	18.01	5.2580	95	385	4.5793	87.0921	
23	18.00	5.2742	35	232	5.0477	95.7055	
24	18.00	5.2676	45	244	5.0013	94.9446	
25	18.01	5.2654	48	285	4.8260	91.6550	
26	18.01	5.2715	57	322	4.7546	90.1944	
27	18.01	5.2696	52	303	4.9392	93.7301	
28	18.01	5.2689	100	385	4.6087	87.4699	
29	18.01	5.2679	110	400	4.2285	80.2692	
30	18.01	5.2643	110	400	4.3621	82.8619	
31	18.01	5.2720				0.0000	
32	18.01	5.2560				0.0000	
33	18.00	5.2688				0.0000	
34	17.99	5.2653				0.0000	
35	17.99	5.2531				0.0000	
36	17.98	5.2606				0.0000	

37	17.98	5.2520				0.0000	
38	17.98	5.2608				0.0000	
39	17.98	5.2627				0.0000	
40	17.99	5.2589				0.0000	
41	17.98	5.2585				0.0000	
42	18.02	5.2667				0.0000	
43	18.00	5.2682				0.0000	
44	18.00	5.2603				0.0000	
45	18.00	5.2647				0.0000	
46	17.99	5.2660				0.0000	
47	18.00	5.2518				0.0000	
48	18.00	5.2614				0.0000	
	18.00	**5.2630**					
	0.01	0.0066					



CompB Spheres

Part #	Diameter(mm) (mm)	Weight (gm)	Velocity (ft/sec)	Rec. Weight (gm)	Percent Recovered	Comments
1	18.00	5.2691	147	5.1504	97.7472	
2	17.99	5.2694	89	5.1141	97.0528	
3	18.00	5.2634	120	4.9779	94.5757	Shear/Clip
4	17.99	5.2635	126	4.6676	88.6786	
5	18.01	5.2658	123	5.0883	96.6292	
6	17.99	5.2655	156	4.8878	92.8269	clipped
7	18.00	5.2680	175	4.8518	92.0995	
8	18.01	5.2520	270	4.8395	92.1458	
9	18.01	5.2628	278	4.8349	91.8693	
10	18.00	5.2572	400	4.4991	85.5798	
11	18.00	5.2609	417	4.5305	86.1164	
12	18.00	5.2673	313	4.7363	89.9189	
13	17.99	5.2700	345	4.2423	80.4991	
14	18.00	5.2684	345	4.6073	87.4516	
15	18.00	5.2647	227	4.8798	92.6890	
16	18.00	5.2599	126	5.0368	95.7585	
17	18.00	5.2386	200	4.6999	89.7167	holes in it
18	18.00	5.2656	189	5.0364	95.6472	
19	18.00	5.2634	345	4.5454	86.3586	
20	17.99	5.2594	333	4.8111	91.4762	
21	18.00	5.2549	370	4.5912	87.3699	
22	18.01	5.2580	385	4.5793	87.0921	
23	18.00	5.2742	232	5.0477	95.7055	
24	18.00	5.2676	244	5.0013	94.9446	
25	18.01	5.2654	285	4.8260	91.6550	
26	18.01	5.2715	322	4.7546	90.1944	
27	18.01	5.2696	303	4.9392	93.7301	
28	18.01	5.2689	385	4.6087	87.4699	
29	18.01	5.2679	400	4.2285	80.2692	
30	18.01	5.2643	400	4.3621	82.8619	

spherical damage

Part #	Weight (gm)	Velocity (ft/sec)	Rec. Weight (gm)	Percent Recovered
1	5.2691	147	5.1504	97.7472
2	5.2694	89	5.1141	97.0528
3	5.2634	120	4.9779	94.5757
4	5.2635	126	4.6676	88.6786
5	5.2658	123	5.0883	96.6292
6	5.2655	156	4.8878	92.8269
7	5.2680	175	4.8518	92.0995
8	5.2520	270	4.8395	92.1458
9	5.2628	278	4.8349	91.8693
10	5.2572	400	4.4991	85.5798
11	5.2609	417	4.5305	86.1164
12	5.2673	313	4.7363	89.9189
13	5.2700	345	4.2423	80.4991
14	5.2684	345	4.6073	87.4516
15	5.2647	227	4.8798	92.6890
16	5.2599	126	5.0368	95.7585
17	5.2386	200	4.6999	89.7167
18	5.2656	189	5.0364	95.6472
19	5.2634	345	4.5454	86.3586
20	5.2594	333	4.8111	91.4762
21	5.2549	370	4.5912	87.3699
22	5.2580	385	4.5793	87.0921
23	5.2742	232	5.0477	95.7055
24	5.2676	244	5.0013	94.9446
25	5.2654	285	4.8260	91.6550
26	5.2715	322	4.7546	90.1944
27	5.2696	303	4.9392	93.7301

Size	Part 1	part 2	part 4	part 7	part 8	part 9	part10	part 11	part 12	part 13	part 14	part 15	
>3360	2.1338	3.4831	2.2782	1.1326	0.803	0.9919	0.2611	0.1996	0.5177	0.4621	0.3375	0.8178	
3360-1000	1.3461	0.8031	1.3854	1.7699	1.3495	1.1947	0.9937	1.0175	1.2533	1.0738	1.174	1.7013	
1000-840	0.3157	0.0683	0.0701	0.1105	0.1166	0.1201	0.065	0.0976	0.1098	0.0906	0.1111	0.1277	
840-590	0.0959	0.1077	0.1281	0.2475	0.2427	0.2438	0.1911	0.2189	0.2702	0.2122	0.2954	0.2564	
590-500	0.0023	0.0516	0.0552	0.1154	0.126	0.1135	0.1084	0.1272	0.1269	0.1124	0.1382	0.1293	
500-420	0.0972	0.0476	0.0537	0.1029	0.1171	0.1223	0.1222	0.1244	0.1394	0.1259	0.1268	0.1069	
420-355	0.1384	0.0566	0.0784	0.1502	0.1744	0.1826	0.155	0.1758	0.2156	0.1866	0.211	0.1894	
355-250	0.1987	0.0918	0.0944	0.2151	0.2549	0.2491	0.2597	0.2935	0.2889	0.2705	0.2672	0.212	
250-212	0.1037	0.0524	0.0631	0.1225	0.1582	0.2406	0.7124	0.1841	0.1755	0.171	0.1912	0.1368	
212-180	0.067	0.0367	0.038	0.0824	0.1107	0.0889	0.0422	0.1178	0.0884	0.0905	0.0852	0.0902	
180-150	0.1055	0.0446	0.0501	0.1128	0.1403	0.1136	0.1364	0.1687	0.164	0.2017	0.1931	0.1796	
150-125	0.1029	0.048	0.0619	0.114	0.1857	0.1138	0.1227	0.22	0.1902	0.1547	0.1805	0.1217	
125-106	0.0928	0.0367	0.0475	0.1017	0.2212	0.1742	0.7549	0.694	0.2388	0.1945	0.2045	0.175	
<106	0.2859	0.188	0.211	0.4221	0.7694	0.7846	0.416	0.8465	0.9134	0.8377	1.0621	0.5855	
Total	5.0859	5.1162	4.6151	4.7996	4.7697	4.7337	4.3408	4.4856	4.6921	4.1842	4.5778	4.8296	56.2303
Weight Recovered	5.1504	5.1141	4.6676	4.8518	4.8395	4.8349	4.4991	4.5305	4.7363	4.2423	4.6073	4.8798	
Percentage	0.987477	1.000411	0.988752	0.989241	0.985577	0.979069	0.964815	0.990089	0.990668	0.986305	0.993597	0.989713	
Velocity	147	89	126	175	270	278	400	417	313	345	345	227	

Size	part 16	part 17	part 18	part 19	Part 20	Part 21	Part 22	Part 23	Part 24	Part 25	Part 26	Part 27	Part 28	Part 29	Part 30
>3360	2.4512	1.3057	1.7008	0.3789	0.41	0.3159	0.2343	0.9889	0.8236	0.5101	0.4037	0.7459	0.187	0	0
3360-1000	1.3368	1.2878	1.2548	1.2186	1.277	1.115	1.1034	1.6389	1.6602	1.4166	1.3155	1.3308	1.0531	1.3604	1.126
1000-840	0.0726	0.1602	0.1059	0.1201	0.0972	0.0999	0.1088	0.1162	0.1163	0.1086	0.1021	0.1246	0.1252	0.0958	0.0982
840-590	0.1841	0.2575	0.2363	0.268	0.2485	0.2476	0.2311	0.2336	0.2608	0.2376	0.2529	0.241	0.2503	0.2191	0.2757
590-500	0.0821	0.1249	0.133	0.13	0.1254	0.1242	0.1275	0.1318	0.1184	0.1221	0.1341	0.1297	0.1264	0.1268	0.1298
500-420	0.0758	0.1118	0.1121	0.1311	0.1255	0.124	0.117	0.1178	0.1142	0.1217	0.1149	0.1213	0.1141	0.104	0.1205
420-355	0.1172	0.1544	0.1717	0.1924	0.1795	0.1957	0.2056	0.1694	0.1741	0.1795	0.1908	0.1713	0.2184	0.1766	0.1882
355-250	0.1362	0.227	0.2145	0.2772	0.2749	0.2734	0.2796	0.24	0.2597	0.2884	0.2733	0.2604	0.2249	0.2457	0.2867
250-212	0.0732	0.1289	0.1202	0.1723	0.1575	0.1538	0.1725	0.153	0.1437	0.1651	0.1627	0.1506	0.1398	0.172	0.1756
212-180	0.0579	0.0885	0.0871	0.1133	0.1477	0.1407	0.1233	0.1029	0.1207	0.1098	0.1168	0.1208	0.0919	0.0978	0.1108
180-150	0.0801	0.1426	0.1324	0.1483	0.1378	0.1425	0.1713	0.1445	0.128	0.1743	0.1504	0.1416	0.1787	0.1466	0.1916
150-125	0.0791	0.1286	0.1257	0.1774	0.1922	0.198	0.1919	0.1755	0.1516	0.1807	0.1923	0.1722	0.1812	0.1668	0.1637
125-106	0.0636	0.1162	0.1194	0.2062	0.2232	0.2501	0.2438	0.0969	0.1304	0.1932	0.1802	0.1638	0.2003	0.1964	0.2061
<106	0.1932	0.4293	0.462	0.9525	1.1417	1.1688	1.2231	0.6905	0.7525	0.9833	1.1035	0.9987	1.2162	0.9986	1.2284
Total	5.0031	4.6634	4.9759	4.4863	4.7381	4.5496	4.5332	4.9999	4.9542	4.791	4.6932	4.8727	4.3075	4.1066	4.3013
Weight Recovered	5.0368	4.6999	5.0364	4.5454	4.8111	4.5912	4.5793	5.0477	5.0013	4.8260	4.7546	4.9392	4.6087	4.2285	4.3621
Percentage	0.993309	0.992234	0.987987	0.986998	0.984827	0.990939	0.989933	0.99053	0.990582	0.992748	0.987086	0.986536	0.934645	0.971172	0.986062
Velocity	126	200	189	345	333	370	385	232	244	285	322	303	385	400	400

Total for all Samples

60.5378

CompB spheres

part 9	%ofTotal	part10	%ofTotal	part 11	%ofTotal	part 12	%ofTotal	part 13	%ofTotal	part 14	%ofTotal	part 15	%ofTotal
0.9919	20.9540106	0.2611	6.015020273	0.1996	4.449794899	0.5177	11.03343919	0.4621	11.04392715	0.3375	7.372537	0.8178	16.93308
1.1947	25.23818577	0.9937	22.89209362	1.0175	22.68369895	1.2533	26.71085441	1.0738	25.66320922	1.174	25.64551	1.7013	35.22652
0.1201	2.537127406	0.065	1.49741983	0.0976	2.175851614	0.1098	2.340103578	0.0906	2.165288466	0.1111	2.42693	0.1277	2.644111
0.2438	5.150305258	0.1911	4.402414302	0.2189	4.880060638	0.2702	5.758615545	0.2122	5.071459299	0.2954	6.452881	0.2564	5.308928
0.1135	2.397701586	0.1084	2.497235533	0.1272	2.835741038	0.1269	2.704545939	0.1124	2.686296066	0.1382	3.018917	0.1293	2.67724
0.1223	2.583602679	0.1222	2.815149281	0.1244	2.773319065	0.1394	2.970951173	0.1259	3.008938387	0.1268	2.769889	0.1069	2.213434
0.1826	3.857447663	0.155	3.570770365	0.1758	3.919208133	0.2156	4.594957482	0.1866	4.459633861	0.211	4.609201	0.1894	3.92165
0.2491	5.262268416	0.2597	5.982768153	0.2935	6.543160335	0.2889	6.157157776	0.2705	6.464796138	0.2672	5.836865	0.212	4.389597
0.2406	5.082704861	0.7124	16.41172134	0.1841	4.104244694	0.1755	3.74032949	0.171	4.086802734	0.1912	4.176679	0.1368	2.832533
0.0889	1.878023533	0.0422	0.972171028	0.1178	2.626181559	0.0884	1.884017817	0.0905	2.162898523	0.0852	1.861156	0.0902	1.867649
0.1136	2.399814099	0.1364	3.142277921	0.1687	3.760923845	0.164	3.495236674	0.2017	4.820515272	0.1931	4.218183	0.1796	3.718734
0.1138	2.404039124	0.1227	2.826667895	0.22	4.904583556	0.1902	4.053622046	0.1547	3.697242006	0.1805	3.942942	0.1217	2.519877
0.1742	3.67999662	0.7549	17.39080354	0.694	15.47173176	0.2388	5.089405597	0.1945	4.648439367	0.2045	4.467211	0.175	3.623488
0.7846	16.57477238	0.416	9.583486915	0.8465	18.87149991	0.9134	19.46676328	0.8377	20.02055351	1.0621	23.2011	0.5855	12.12316
4.7337	100	4.3408	100	4.4856	100	4.6921	100	4.1842	100	4.5778	100	4.8296	100
4.8349		4.4991		4.5305		4.7363		4.2423		4.6073		4.8798	
0.979068854		0.9648152		0.9900894		0.99066782		0.986305		0.993597		0.989713	
278		400		417		313		345		345		227	

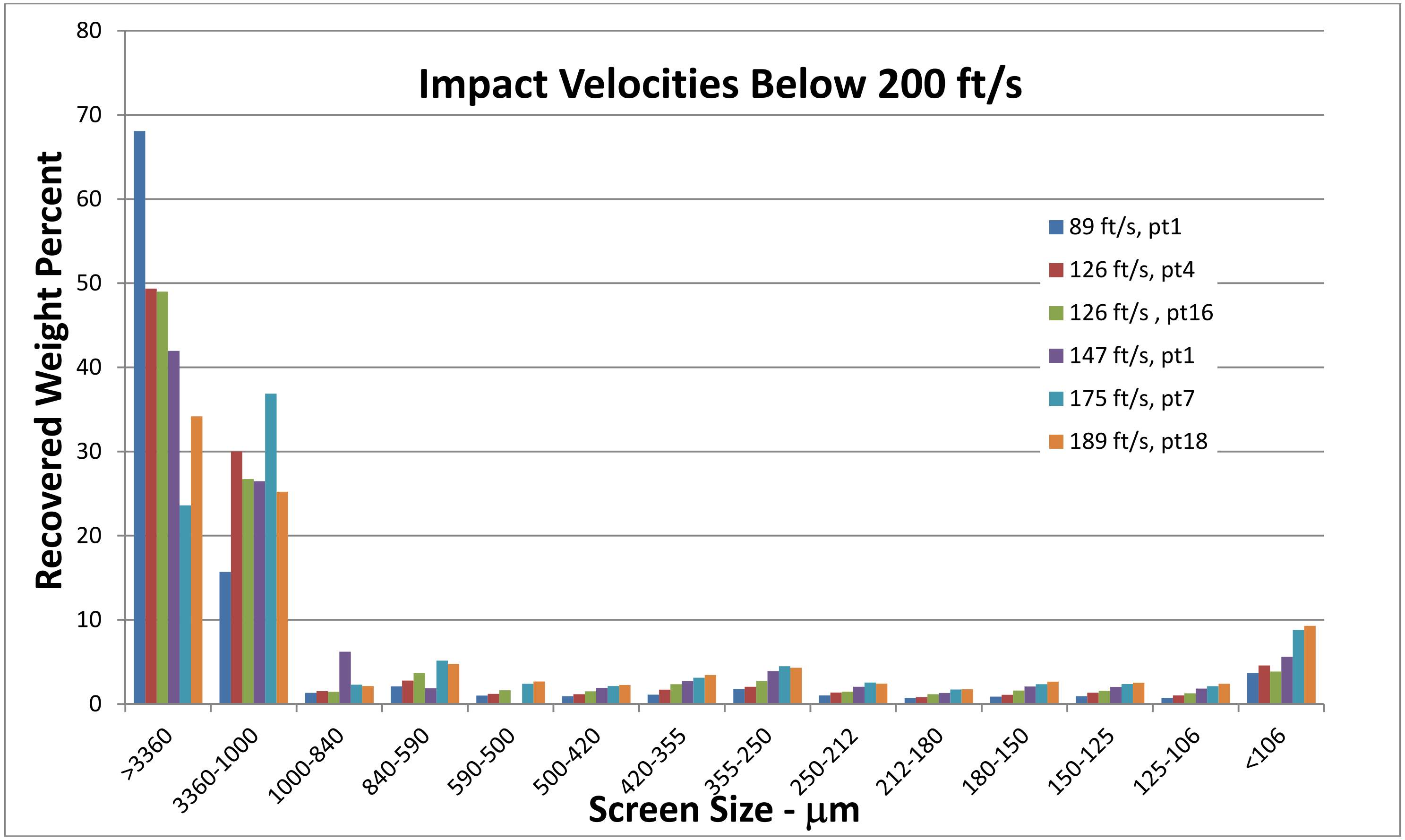
Pt21 - g	%ofTotal	Pt22 - g	%ofTotal	Pt23 - g	%ofTotal	pt24 - g	%ofTotal	Pt25 - g	%ofTotal	Pt26 - g	%ofTotal	Pt27 - g	%ofTotal
0.3159	6.943467558	0.2343	5.168534369	0.9889	19.77839557	0.8236	16.62427839	0.5101	10.64704655	0.4037	8.601807	0.7459	15.30773
1.115	24.50764902	1.1034	24.34042178	1.6389	32.77865557	1.6602	33.5109604	1.4166	29.56793989	1.3155	28.02992	1.3308	27.31135
0.0999	2.195797433	0.1088	2.40007059	0.1162	2.324046481	0.1163	2.347503129	0.1086	2.266750157	0.1021	2.175488	0.1246	2.557104
0.2476	5.44223668	0.2311	5.097944057	0.2336	4.672093442	0.2608	5.264220258	0.2376	4.959298685	0.2529	5.388647	0.241	4.945923
0.1242	2.729910322	0.1275	2.812582723	0.1318	2.636052721	0.1184	2.389891405	0.1221	2.548528491	0.1341	2.857325	0.1297	2.661769
0.124	2.725514331	0.117	2.580958263	0.1178	2.356047121	0.1142	2.305114852	0.1217	2.540179503	0.1149	2.448223	0.1213	2.48938
0.1957	4.301477053	0.2056	4.535427513	0.1694	3.388067761	0.1741	3.51418998	0.1795	3.746608224	0.1908	4.065456	0.1713	3.515505
0.2734	6.009319501	0.2796	6.167828466	0.24	4.800096002	0.2597	5.242016875	0.2884	6.019620121	0.2733	5.823319	0.2604	5.34406
0.1538	3.380516969	0.1725	3.805258978	0.153	3.060061201	0.1437	2.900569214	0.1651	3.446044667	0.1627	3.466718	0.1506	3.090689
0.1407	3.092579567	0.1233	2.719932939	0.1029	2.058041161	0.1207	2.436316661	0.1098	2.29179712	0.1168	2.488707	0.1208	2.479118
0.1425	3.132143485	0.1713	3.778787611	0.1445	2.890057801	0.128	2.583666384	0.1743	3.638071384	0.1504	3.204636	0.1416	2.905986
0.198	4.352030948	0.1919	4.233212742	0.1755	3.510070201	0.1516	3.060029874	0.1807	3.771655187	0.1923	4.097418	0.1722	3.533975
0.2501	5.497186566	0.2438	5.378099356	0.0969	1.938038761	0.1304	2.632110129	0.1932	4.032561052	0.1802	3.839598	0.1638	3.361586
1.1688	25.69017056	1.2231	26.98094062	0.6905	13.81027621	0.7525	15.18913245	0.9833	20.52389898	1.1035	23.51274	0.9987	20.49582
4.5496	100	4.5332	100	4.9999	100	4.9542	100	4.791	100	4.6932	100	4.8727	100
4.5912		4.5793		5.0477		5.0013		4.8260		4.7546		4.9392	
0.990939188		0.989933		0.9905303		0.99058245		0.992748		0.987086		0.986536	
370		385		232		244		285		322		303	

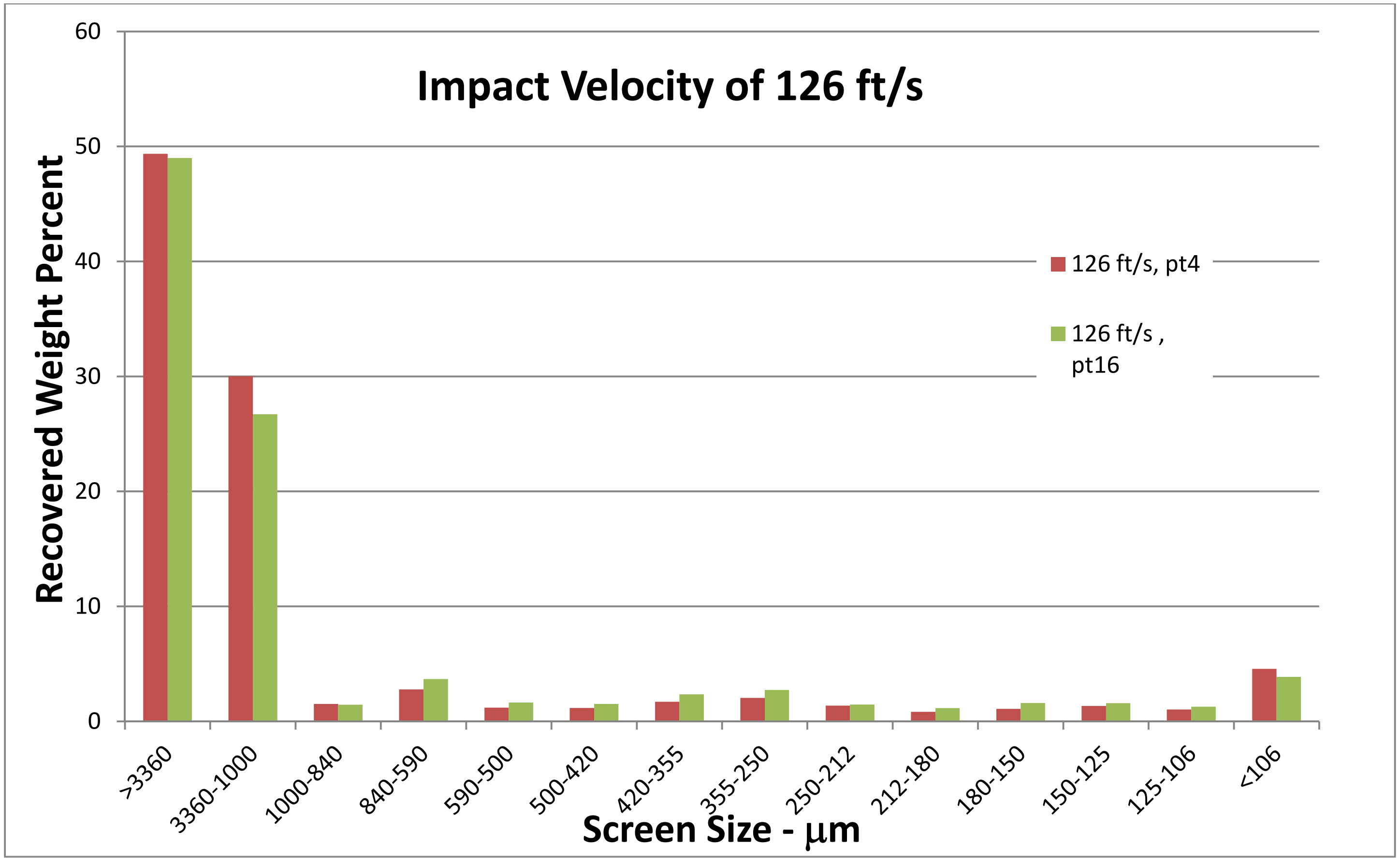
Pt16 - g	%ofTotal3	Pt1- g	%ofTotal4	Pt7- g	%ofTotal5	Pt18- g	%ofTotal6
2.4512	48.9936	2.1338	41.9552	1.1326	23.5978	1.7008	34.1808
1.3368	26.7194	1.3461	26.4673	1.7699	36.8760	1.2548	25.2175
0.0726	1.4511	0.3157	6.2074	0.1105	2.3023	0.1059	2.1283
0.1841	3.6797	0.0959	1.8856	0.2475	5.1567	0.2363	4.7489
0.0821	1.6410	0.0023	0.0452	0.1154	2.4044	0.133	2.6729
0.0758	1.5151	0.0972	1.9112	0.1029	2.1439	0.1121	2.2529
0.1172	2.3425	0.1384	2.7212	0.1502	3.1294	0.1717	3.4506
0.1362	2.7223	0.1987	3.9069	0.2151	4.4816	0.2145	4.3108
0.0732	1.4631	0.1037	2.0390	0.1225	2.5523	0.1202	2.4156
0.0579	1.1573	0.067	1.3174	0.0824	1.7168	0.0871	1.7504
0.0801	1.6010	0.1055	2.0744	0.1128	2.3502	0.1324	2.6608
0.0791	1.5810	0.1029	2.0232	0.114	2.3752	0.1257	2.5262
0.0636	1.2712	0.0928	1.8247	0.1017	2.1189	0.1194	2.3996
0.1932	3.8616	0.2859	5.6214	0.4221	8.7945	0.462	9.2848
5.0031	100	5.0859	100	4.7996	100	4.9759	100
5.0368		5.1504		4.8518		5.0364	
99.33		98.75		98.92		98.80	
126		**147**		**175**		**189**	

Pt23 - g	%ofTotal3	pt24 - g	%ofTotal4	part 8	%ofTotal5	part 9	%ofTotal6	Pt25 - g	%ofTotal7
0.9889	19.7784	0.8236	16.6243	0.803	16.8354	0.9919	20.9540	0.5101	10.6470
1.6389	32.7787	1.6602	33.5110	1.3495	28.2932	1.1947	25.2382	1.4166	29.5679
0.1162	2.3240	0.1163	2.3475	0.1166	2.4446	0.1201	2.5371	0.1086	2.2668
0.2336	4.6721	0.2608	5.2642	0.2427	5.0884	0.2438	5.1503	0.2376	4.9593
0.1318	2.6361	0.1184	2.3899	0.126	2.6417	0.1135	2.3977	0.1221	2.5485
0.1178	2.3560	0.1142	2.3051	0.1171	2.4551	0.1223	2.5836	0.1217	2.5402
0.1694	3.3881	0.1741	3.5142	0.1744	3.6564	0.1826	3.8574	0.1795	3.7466
0.24	4.8001	0.2597	5.2420	0.2549	5.3442	0.2491	5.2623	0.2884	6.0196
0.153	3.0601	0.1437	2.9006	0.1582	3.3168	0.2406	5.0827	0.1651	3.4460
0.1029	2.0580	0.1207	2.4363	0.1107	2.3209	0.0889	1.8780	0.1098	2.2918
0.1445	2.8901	0.128	2.5837	0.1403	2.9415	0.1136	2.3998	0.1743	3.6381
0.1755	3.5101	0.1516	3.0600	0.1857	3.8933	0.1138	2.4040	0.1807	3.7717
0.0969	1.9380	0.1304	2.6321	0.2212	4.6376	0.1742	3.6800	0.1932	4.0326
0.6905	13.8103	0.7525	15.1891	0.7694	16.1310	0.7846	16.5748	0.9833	20.5239
4.9999	100	4.9542	100	4.7697	100	4.7337	100	4.791	100
5.0477		5.0013		4.8395		4.8349		4.8260	
99.05		99.06		98.56		97.91		99.27	
232		**244**		**270**		**278**		**285**	

Pt26 - g	%ofTotal3	Pt20 - g	%ofTotal4	part 13	%ofTotal5	part 14	%ofTotal6
0.4037	8.60181	0.41	8.6533	0.4621	11.0439	0.3375	7.372537027
1.3155	28.02992	1.277	26.9517	1.0738	25.6632	1.174	25.64550658
0.1021	2.17549	0.0972	2.0515	0.0906	2.1653	0.1111	2.426929966
0.2529	5.38865	0.2485	5.2447	0.2122	5.0715	0.2954	6.452881297
0.1341	2.85733	0.1254	2.6466	0.1124	2.6863	0.1382	3.018917384
0.1149	2.44822	0.1255	2.6487	0.1259	3.0089	0.1268	2.769889467
0.1908	4.06546	0.1795	3.7884	0.1866	4.4596	0.211	4.609200926
0.2733	5.82332	0.2749	5.8019	0.2705	6.4648	0.2672	5.83686487
0.1627	3.46672	0.1575	3.3241	0.171	4.0868	0.1912	4.176678754
0.1168	2.48871	0.1477	3.1173	0.0905	2.1629	0.0852	1.861156014
0.1504	3.20464	0.1378	2.9083	0.2017	4.8205	0.1931	4.218183407
0.1923	4.09742	0.1922	4.0565	0.1547	3.6972	0.1805	3.942942025
0.1802	3.83960	0.2232	4.7107	0.1945	4.6484	0.2045	4.467211324
1.1035	23.51274	1.1417	24.0962	0.8377	20.0206	1.0621	23.20110097
4.6932	100	4.7381	100	4.1842	100	4.5778	100
4.7546		4.8111		4.2423		4.6073	
98.71		98.48		98.63		99.36	
322		**333**		**345**		**345**	

Pt22 - g	%ofTotal2	Part 28	%of Total	part10	%ofTotal3	Part 29	%of Total2	Part 30	%of Total22	part 11	%ofTotal4	Column2
0.2343	5.1685	0.187	4.3413	0.2611	6.0150	0	0.0000	0	0.0000	0.1996	4.4498	
1.1034	24.3404	1.0531	24.4481	0.9937	22.8921	1.3604	33.1272	1.126	26.1781	1.0175	22.6837	
0.1088	2.4001	0.1252	2.9066	0.065	1.4974	0.0958	2.3328	0.0982	2.2830	0.0976	2.1759	
0.2311	5.0979	0.2503	5.8108	0.1911	4.4024	0.2191	5.3353	0.2757	6.4097	0.2189	4.8801	
0.1275	2.8126	0.1264	2.9344	0.1084	2.4972	0.1268	3.0877	0.1298	3.0177	0.1272	2.8357	
0.117	2.5810	0.1141	2.6489	0.1222	2.8151	0.104	2.5325	0.1205	2.8015	0.1244	2.7733	
0.2056	4.5354	0.2184	5.0702	0.155	3.5708	0.1766	4.3004	0.1882	4.3754	0.1758	3.9192	
0.2796	6.1678	0.2249	5.2211	0.2597	5.9828	0.2457	5.9831	0.2867	6.6654	0.2935	6.5432	
0.1725	3.8053	0.1398	3.2455	0.7124	16.4117	0.172	4.1884	0.1756	4.0825	0.1841	4.1042	
0.1233	2.7199	0.0919	2.1335	0.0422	0.9722	0.0978	2.3815	0.1108	2.5760	0.1178	2.6262	
0.1713	3.7788	0.1787	4.1486	0.1364	3.1423	0.1466	3.5699	0.1916	4.4545	0.1687	3.7609	
0.1919	4.2332	0.1812	4.2066	0.1227	2.8267	0.1668	4.0618	0.1637	3.8058	0.22	4.9046	
0.2438	5.3781	0.2003	4.6500	0.7549	17.3908	0.1964	4.7825	0.2061	4.7916	0.694	15.4717	
1.2231	26.9809	1.2162	28.2345	0.416	9.5835	0.9986	24.3170	1.2284	28.5588	0.8465	18.8715	
4.5332	100	4.3075	100.0000	4.3408	100	4.1066	100.0000	4.3013	100.0000	4.4856	100	
4.5793		4.6087		4.4991		4.2285		4.3621		4.5305		
98.99		0.9346453		96.48		0.97117181		0.986062		99.01		
385		385		**400**		400		400		**417**		


Impact Velocities Below 200 ft/s
Recovered Weight Percent
80
70
60
50
40
30
20
10
0
89 ft/s, pt1
126 ft/s, pt4
126 ft/s , pt16
147 ft/s, pt1
175 ft/s, pt7
189 ft/s, pt18
>3360
3360-1000
1000-840
840-590
590-500
500-420
420-355
355-250
250-212
212-180
180-150
150-125
125-106
<106
Screen Size - µm


Impact Velocity of 126 ft/s
Recovered Weight Percent
60
50
40
30
20
10
0
126 ft/s, pt4
126 ft/s , pt16
>3360
3360-1000
1000-840
840-590
590-500
500-420
420-355
355-250
250-212
212-180
180-150
150-125
125-106
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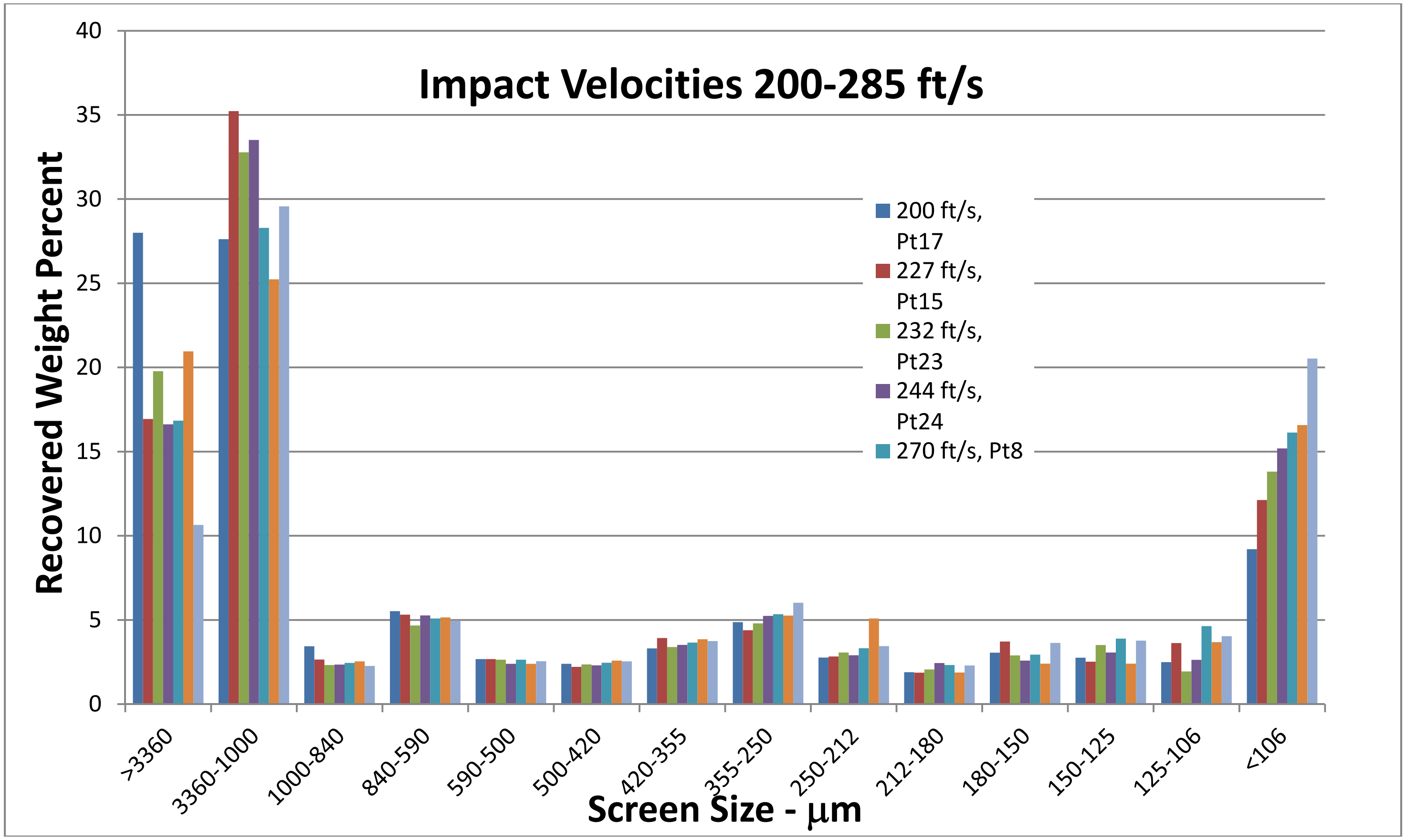
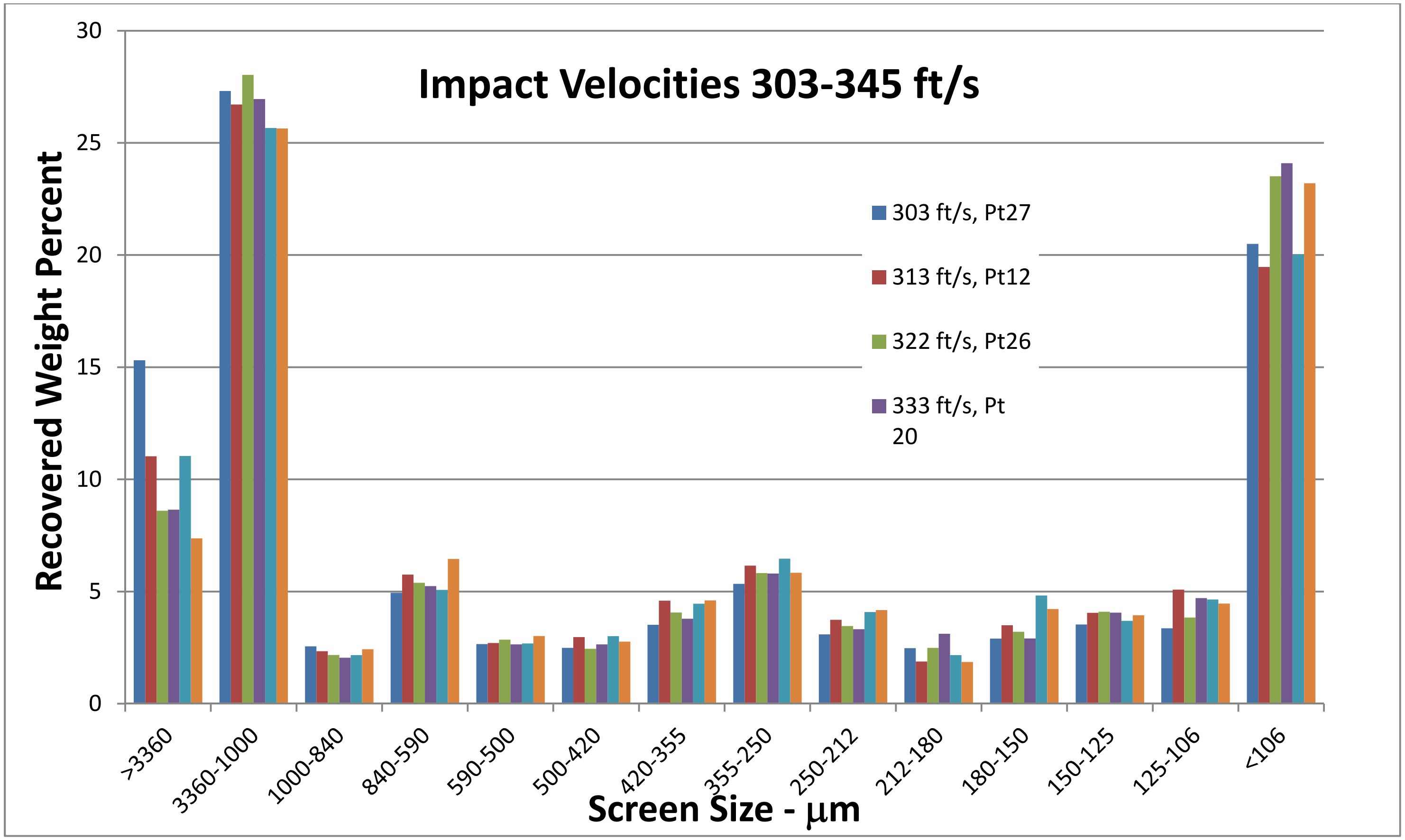
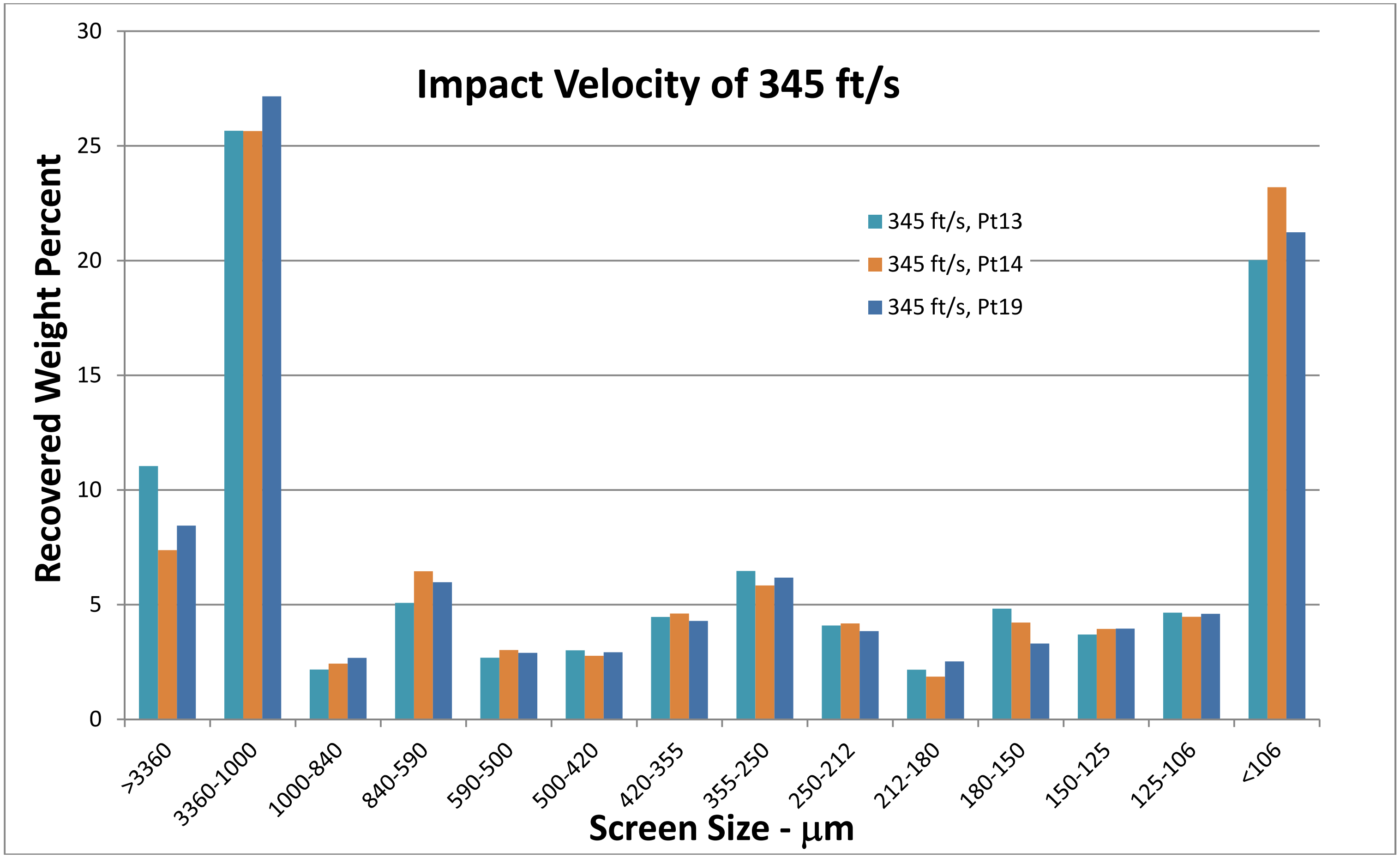
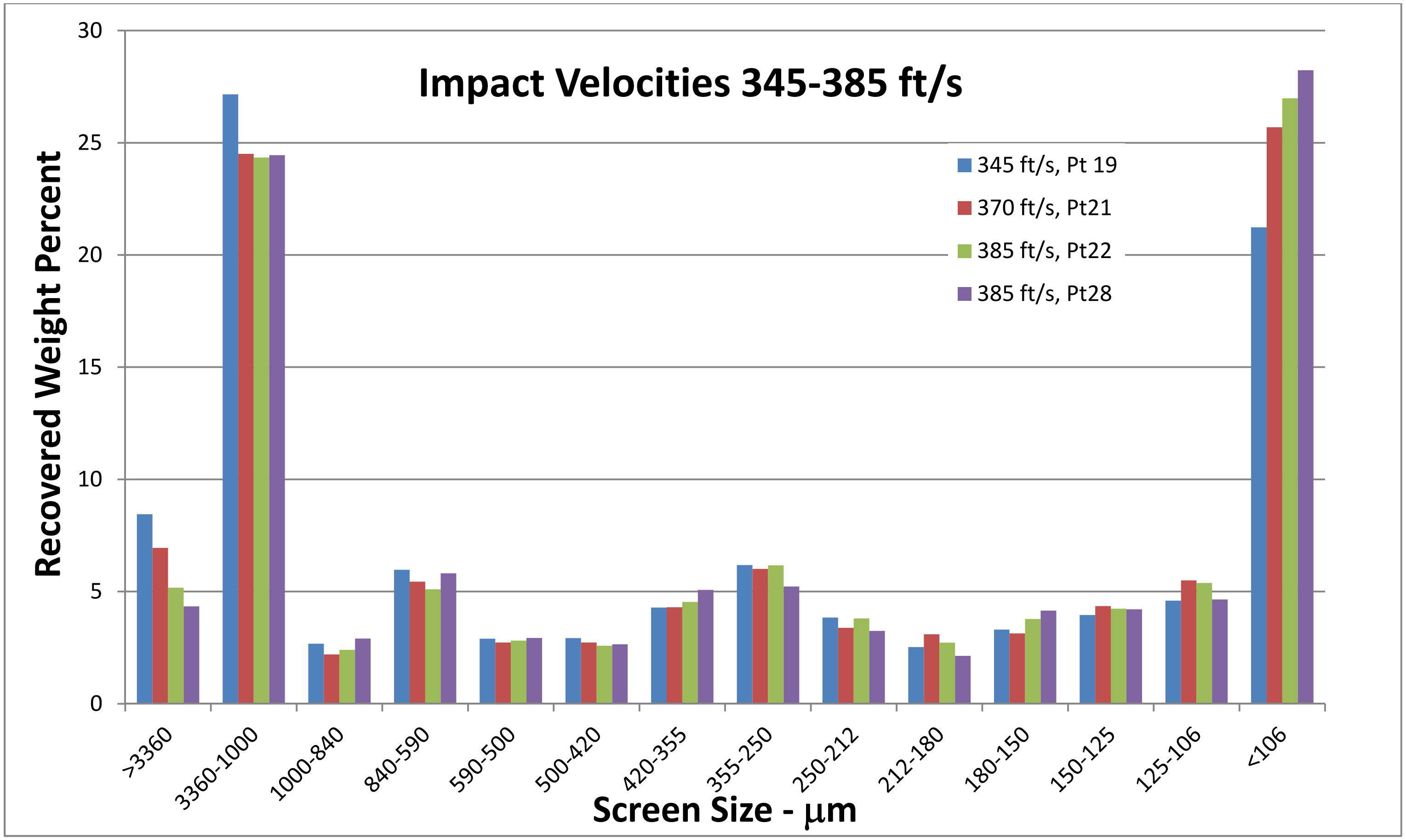
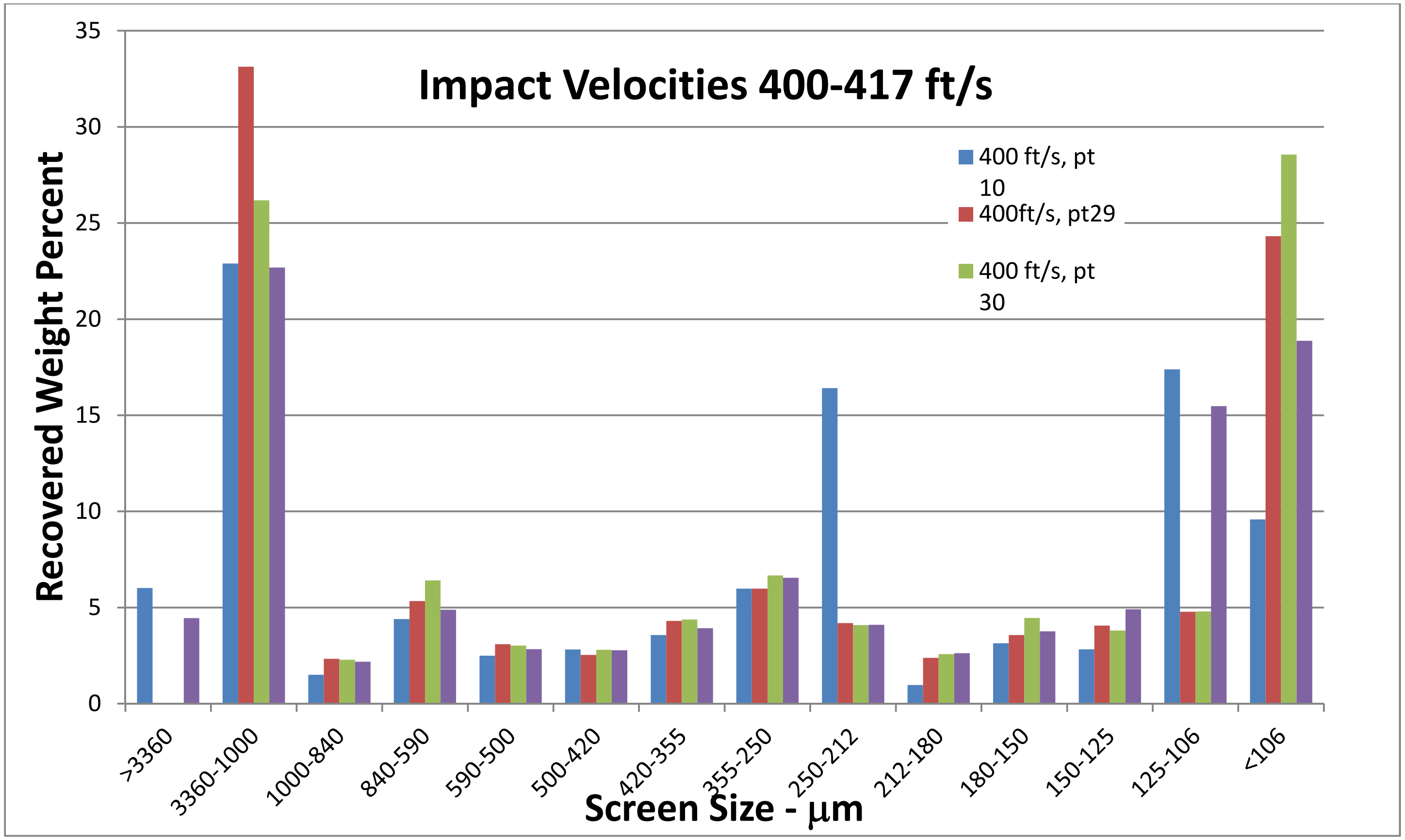
Screen Size - µm

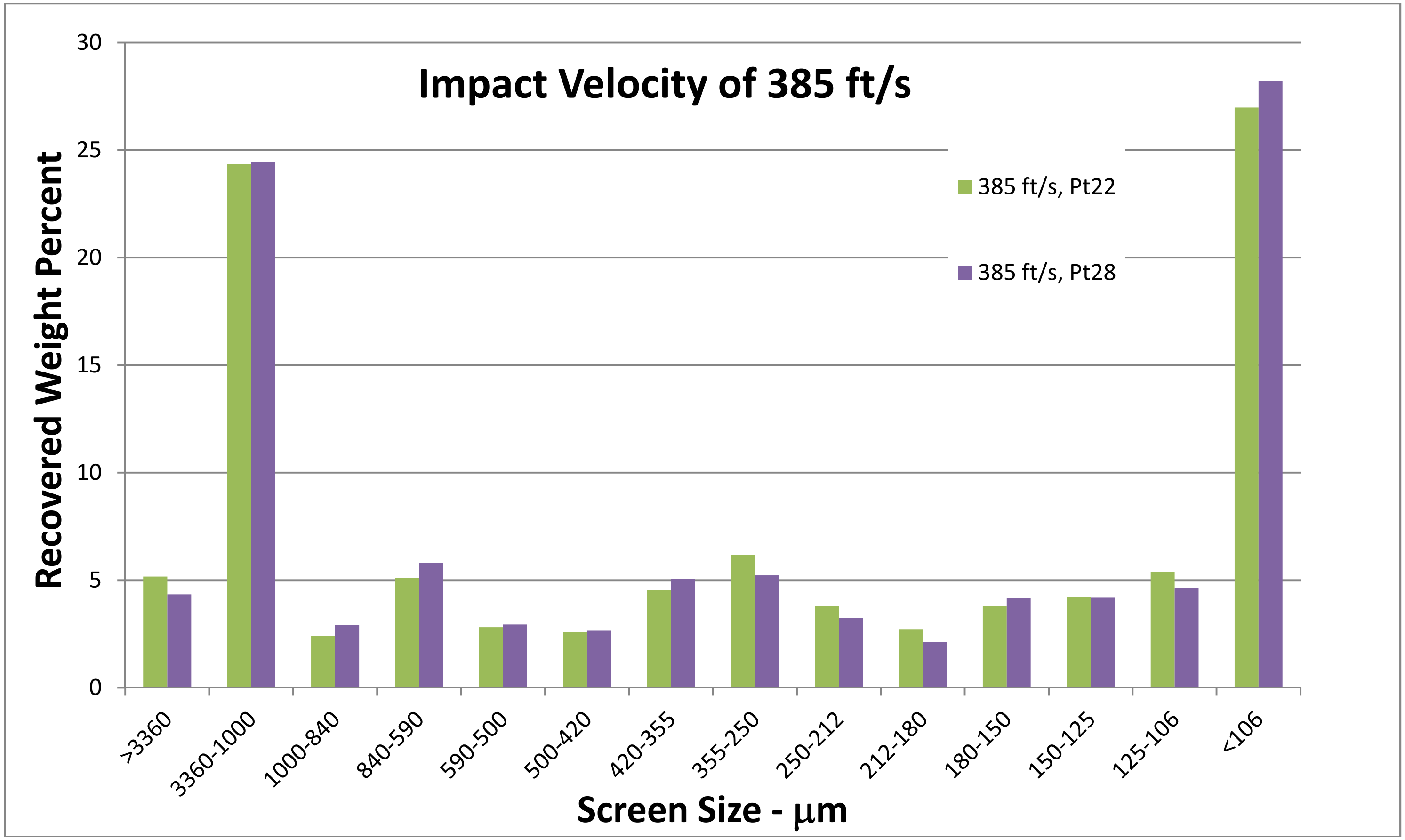

Impact Velocities 200-285 ft/s
Recovered Weight Percent
Screen Size - μm
200 ft/s, Pt17
227 ft/s, Pt15
232 ft/s, Pt23
244 ft/s, Pt24
270 ft/s, Pt8
0
5
10
15
20
25
30
35
40
>3360
3360-1000
1000-840
840-590
590-500
500-420
420-355
355-250
250-212
212-180
180-150
150-125
125-106
<106

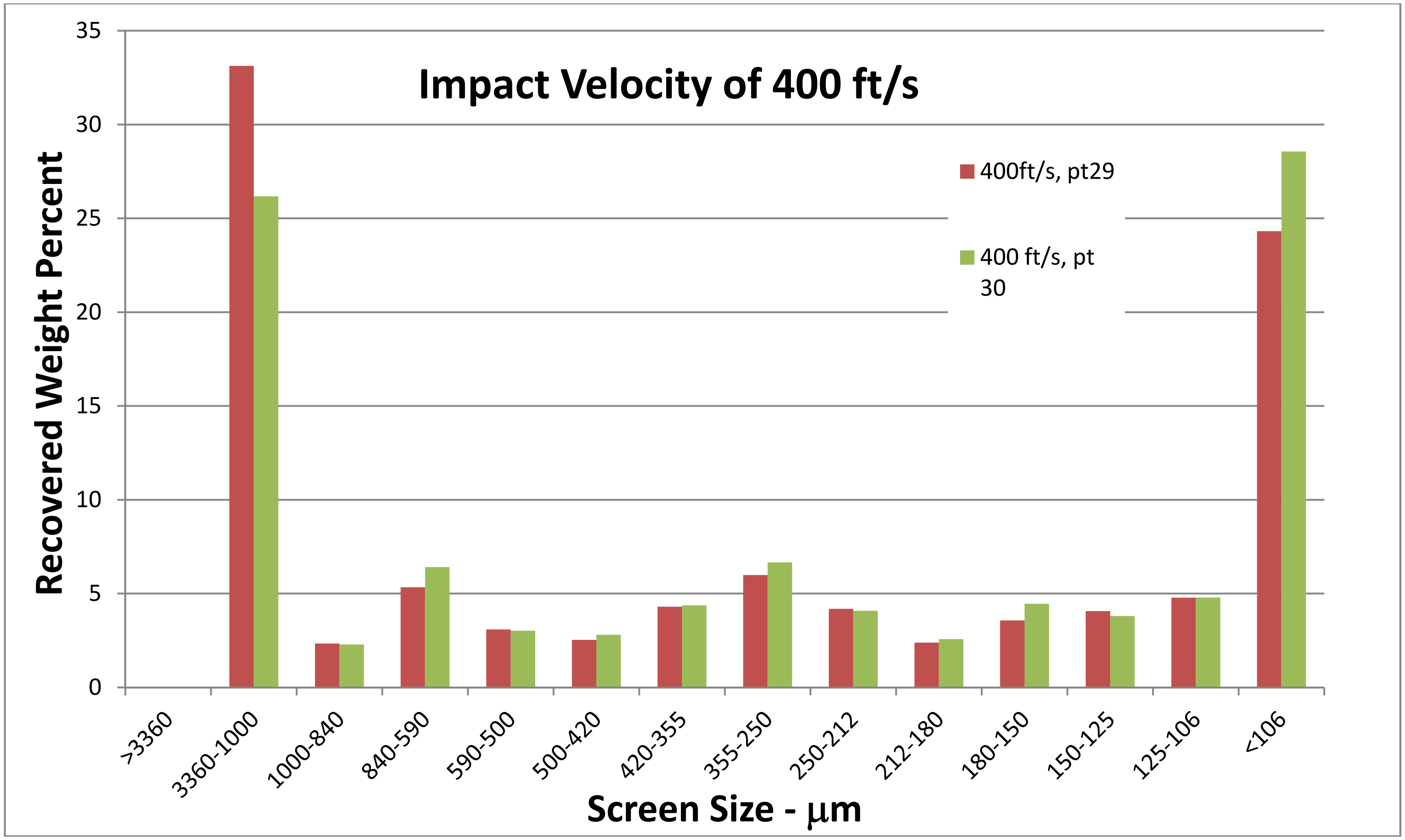

Impact Velocities 303-345 ft/s
Recovered Weight Percent
Screen Size - µm
303 ft/s, Pt27
313 ft/s, Pt12
322 ft/s, Pt26
333 ft/s, Pt 20
0
5
10
15
20
25
30
>3360
3360-1000
1000-840
840-590
590-500
500-420
420-355
355-250
250-212
212-180
180-150
150-125
125-106
<106


Impact Velocity of 345 ft/s
Recovered Weight Percent
Screen Size - μm
0
5
10
15
20
25
30
345 ft/s, Pt13
345 ft/s, Pt14
345 ft/s, Pt19
>3360
3360-1000
1000-840
840-590
590-500
500-420
420-355
355-250
250-212
212-180
180-150
150-125
125-106
<106


Impact Velocities 345-385 ft/s
Recovered Weight Percent
Screen Size - μm
345 ft/s, Pt 19
370 ft/s, Pt21
385 ft/s, Pt22
385 ft/s, Pt28
0
5
10
15
20
25
30
>3360
3360-1000
1000-840
840-590
590-500
500-420
420-355
355-250
250-212
212-180
180-150
150-125
125-106
<106


Impact Velocities 400-417 ft/s
Recovered Weight Percent
Screen Size - μm
400 ft/s, pt 10
400ft/s, pt29
400 ft/s, pt 30
35
30
25
20
15
10
5
0
>3360
3360-1000
1000-840
840-590
590-500
500-420
420-355
355-250
250-212
212-180
180-150
150-125
125-106
<106

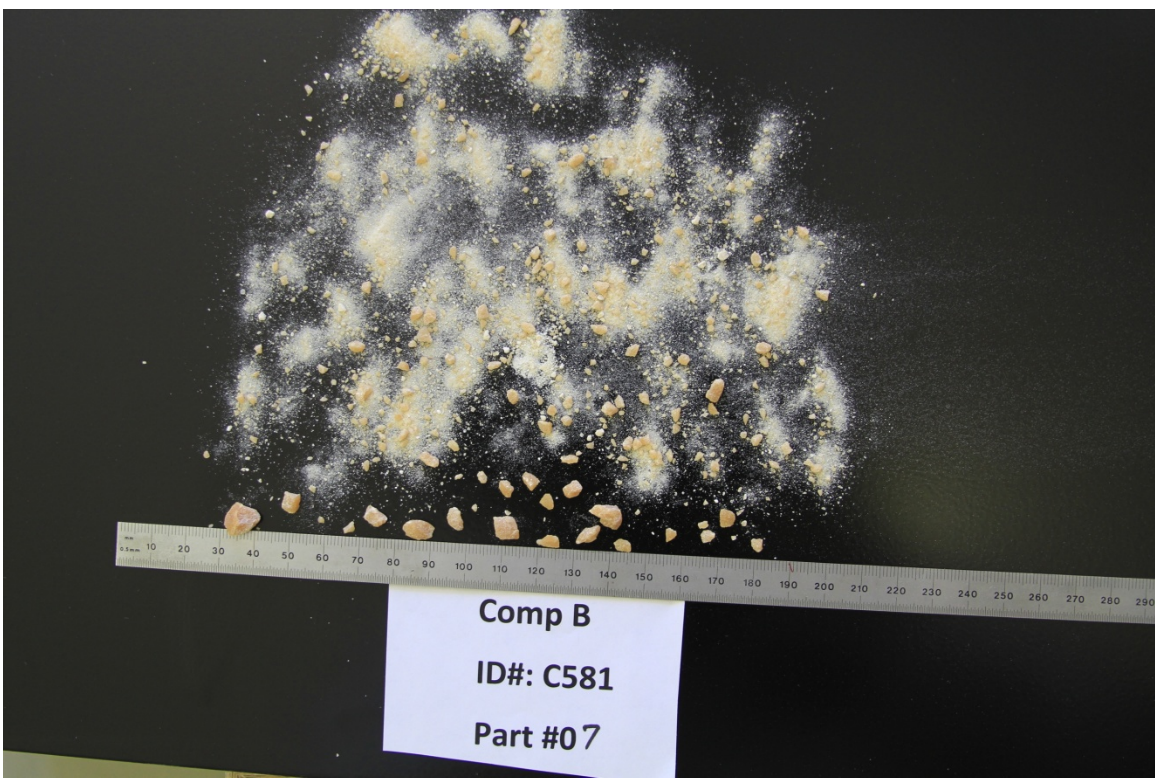

Impact Velocity of 385 ft/s
Recovered Weight Percent
0
5
10
15
20
25
30
385 ft/s, Pt22
385 ft/s, Pt28
>3360
3360-1000
1000-840
840-590
590-500
500-420
420-355
355-250
250-212
212-180
180-150
150-125
125-106
<106
Screen Size - µm


Impact Velocity of 400 ft/s
Recovered Weight Percent
35
30
25
20
15
10
5
0
400ft/s, pt29
400 ft/s, pt 30
>3360
3360-1000
1000-840
840-590
590-500
500-420
420-355
355-250
250-212
212-180
180-150
150-125
125-106
<106
Screen Size - µm


Comp B
ID#: C581
Part # 1


Comp B
ID#: C581
Part #02


Comp B
ID#: C581
Part #04


Comp B
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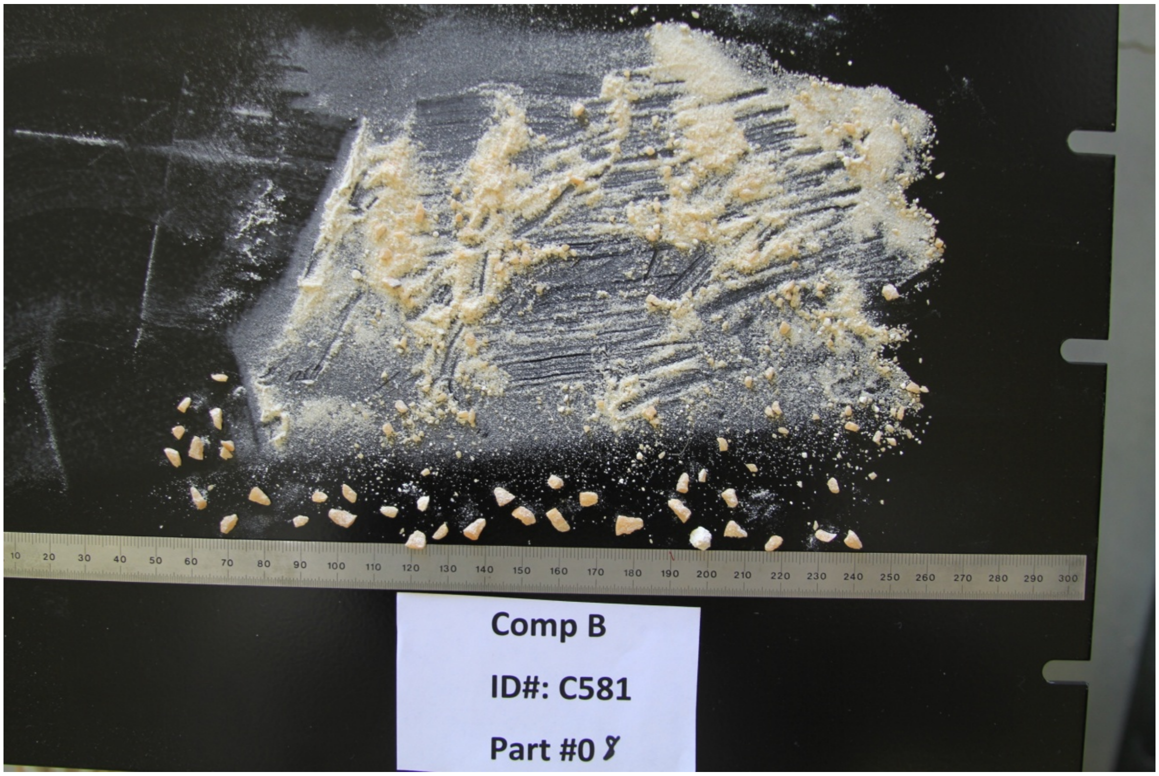
Part #07


Comp B
ID#: C581
Part #08


Comp B
ID#: C581
Part #09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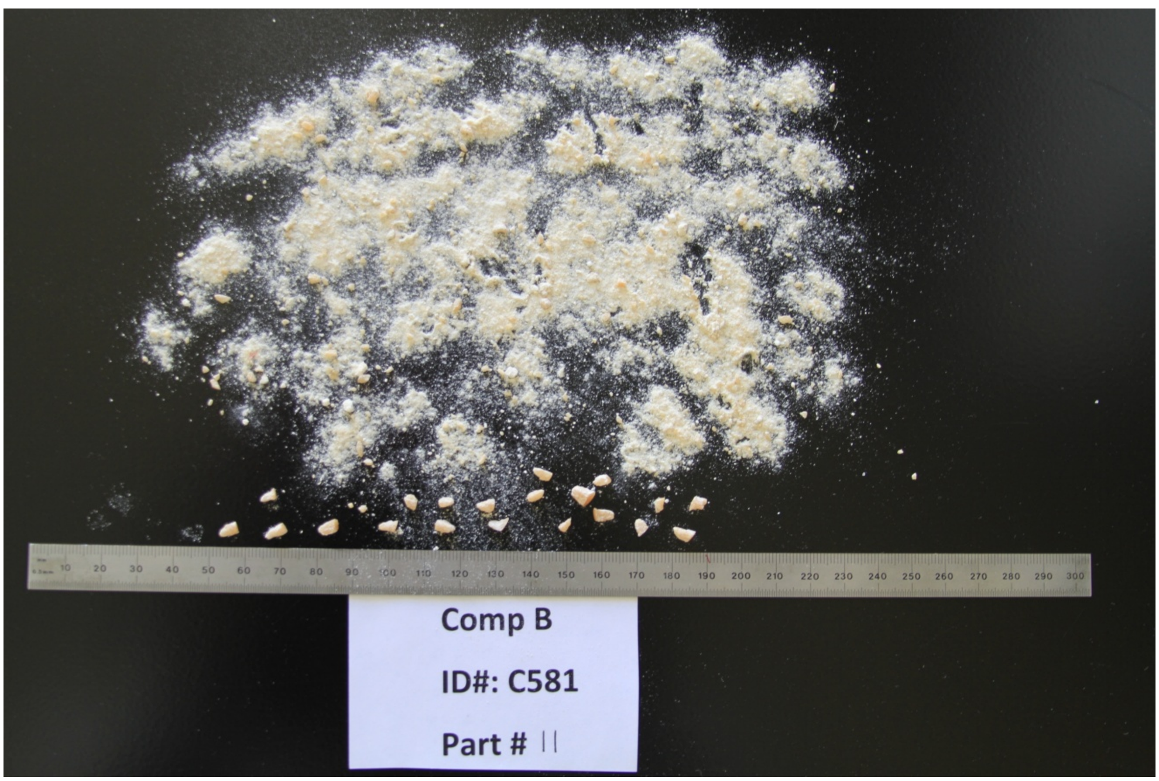
Comp B
ID#: C581
Part # 10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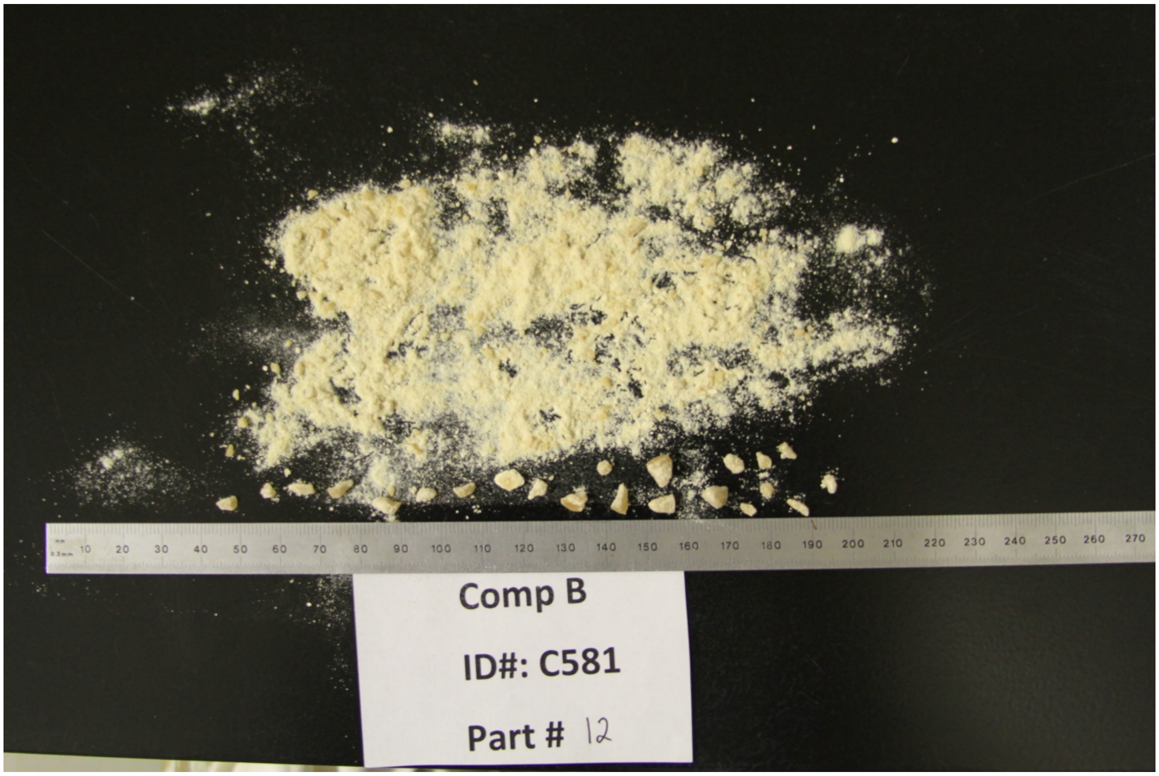
Comp B
ID#: C581
Part # 11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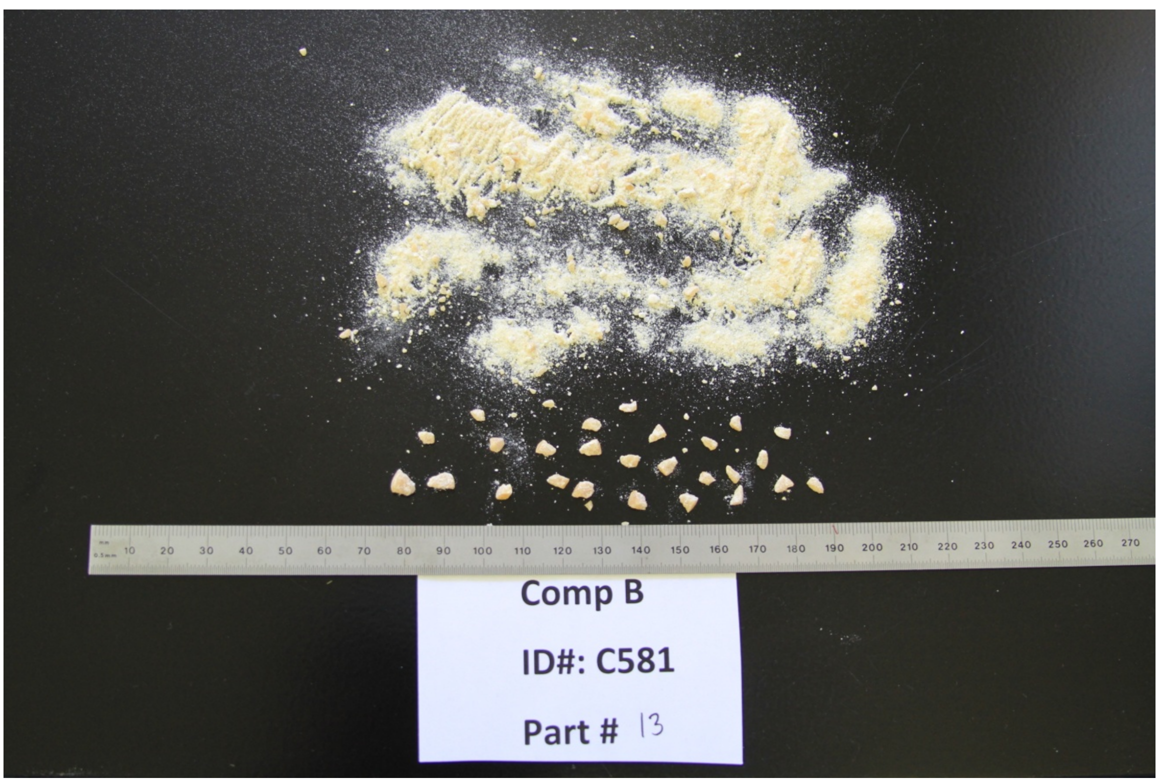
Comp B
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Part # 13


Comp B
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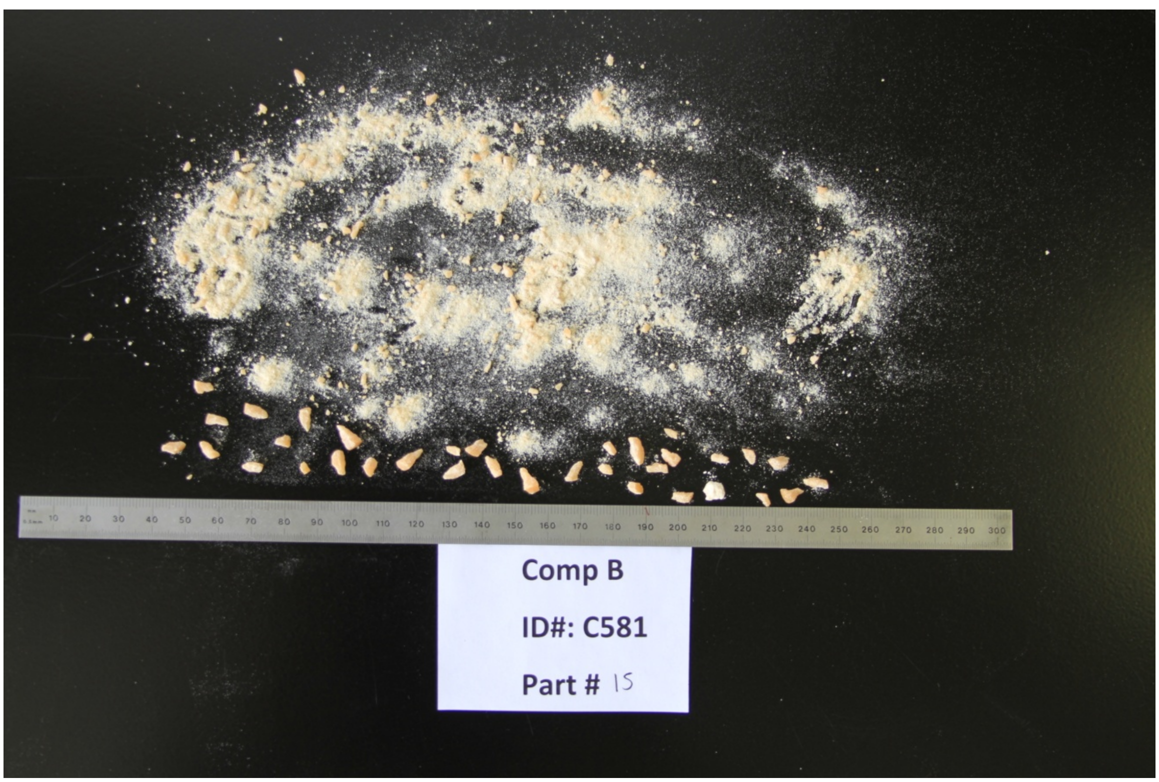
Part # 14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Part # 15


Comp B
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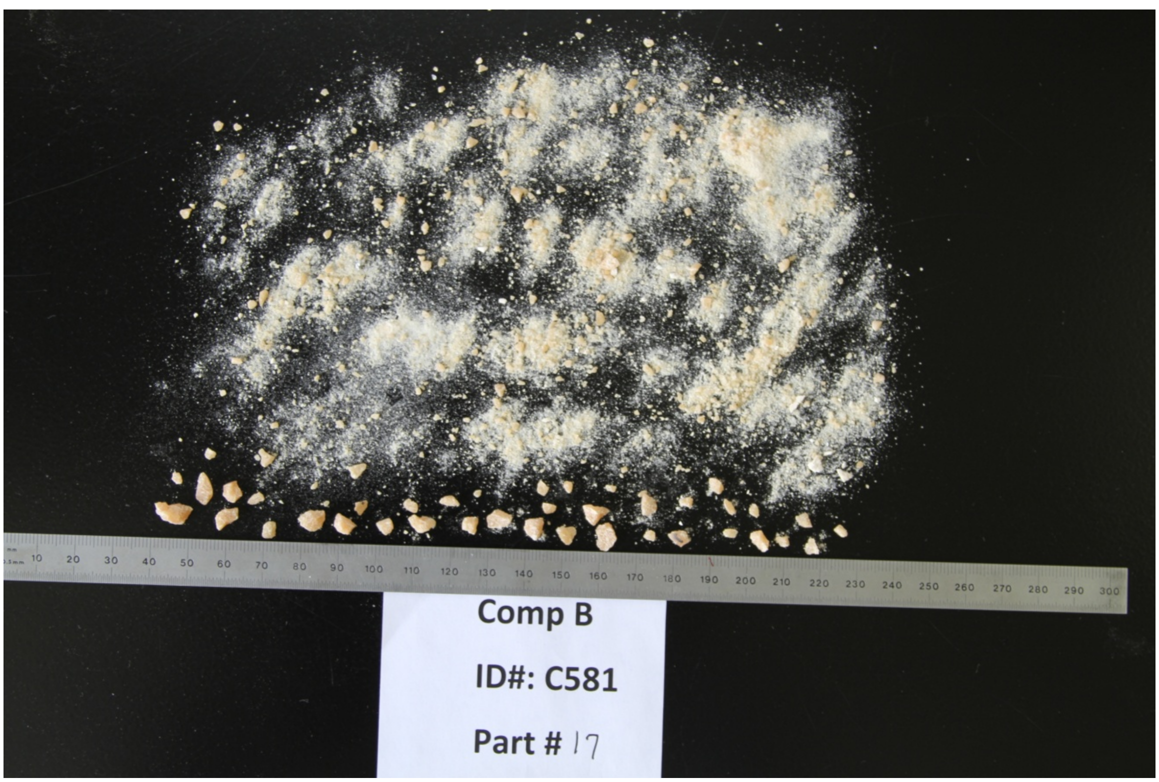
Part # 16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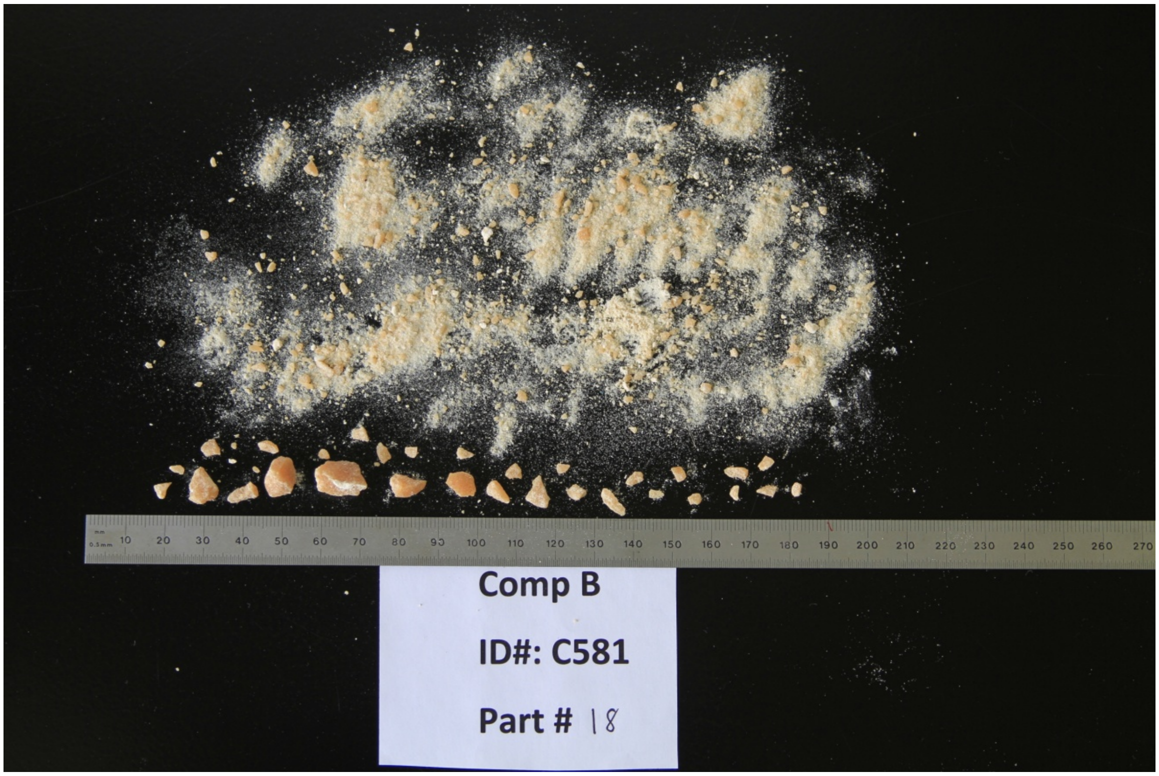
Part # 17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Part # 18


Comp B
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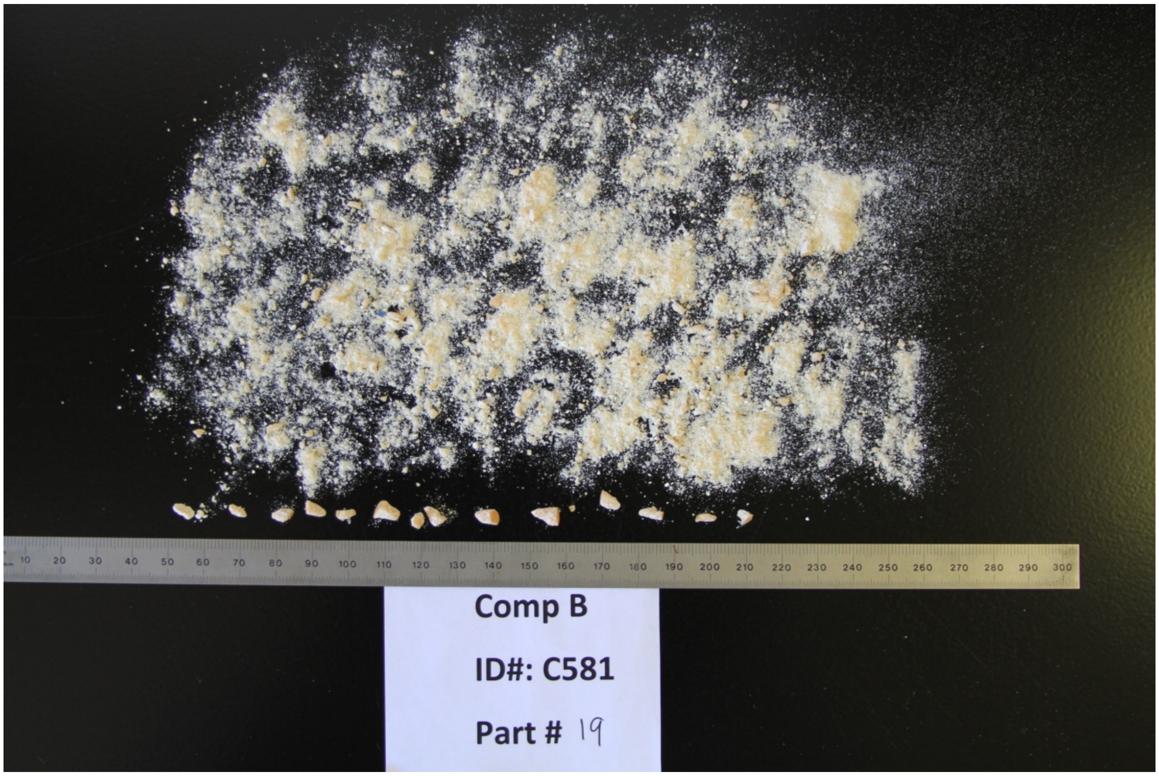
Part # 18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Part # 19


Comp B
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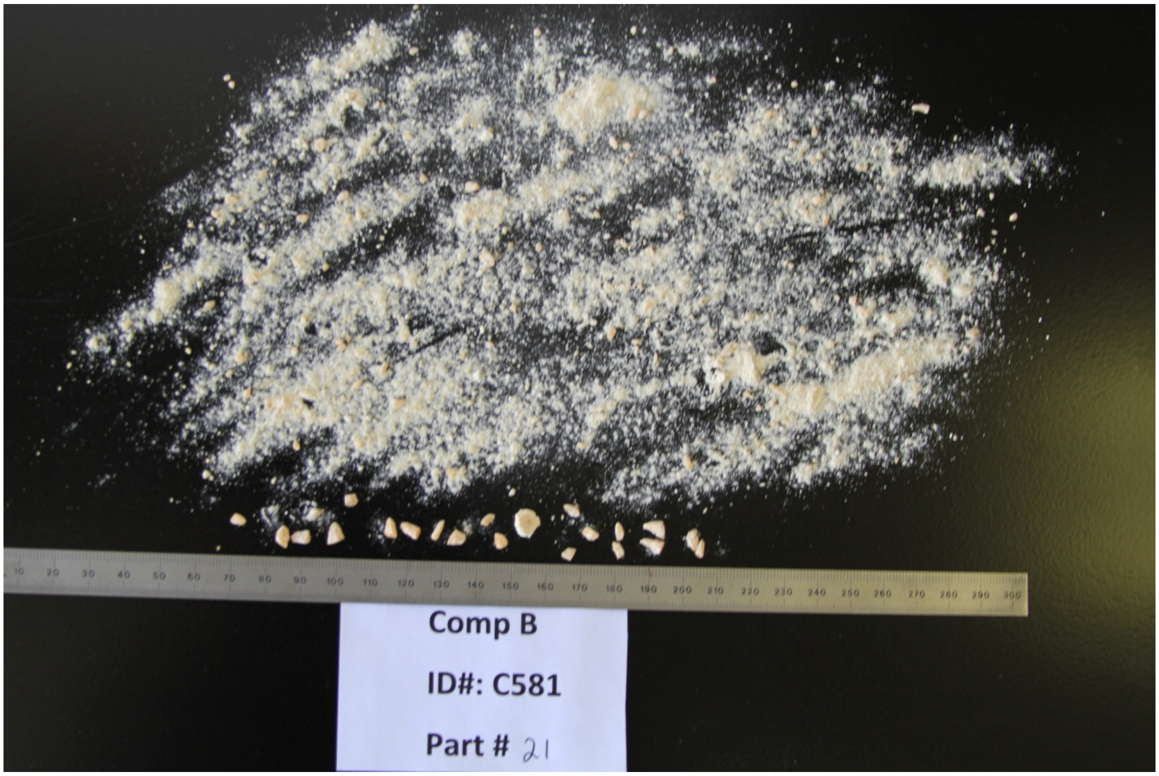
Part # 20


Comp B
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Part # 21


Comp B
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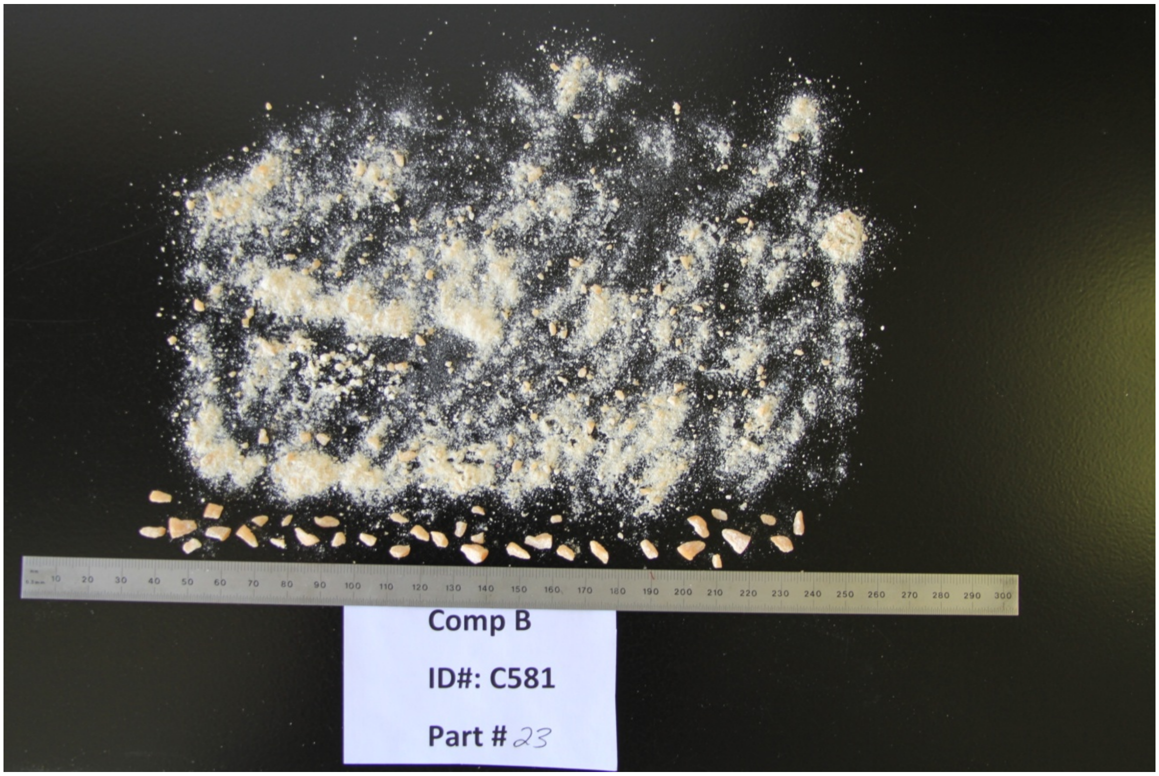
Part # 22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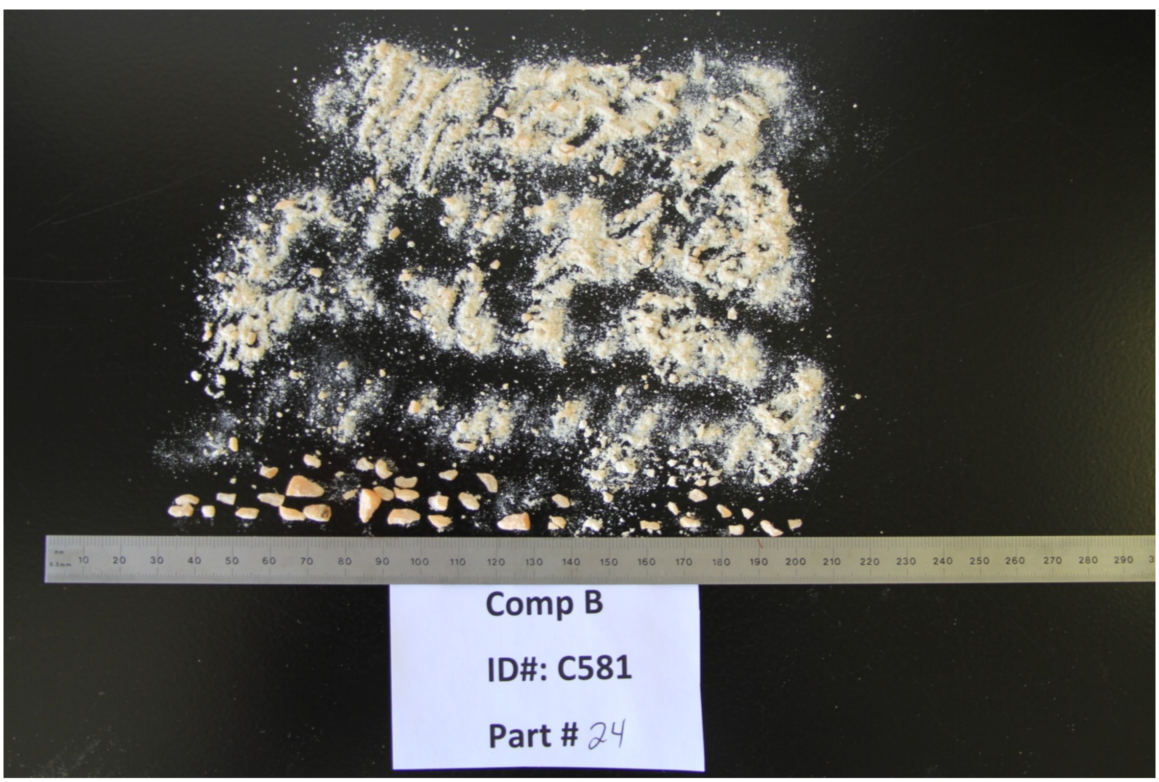
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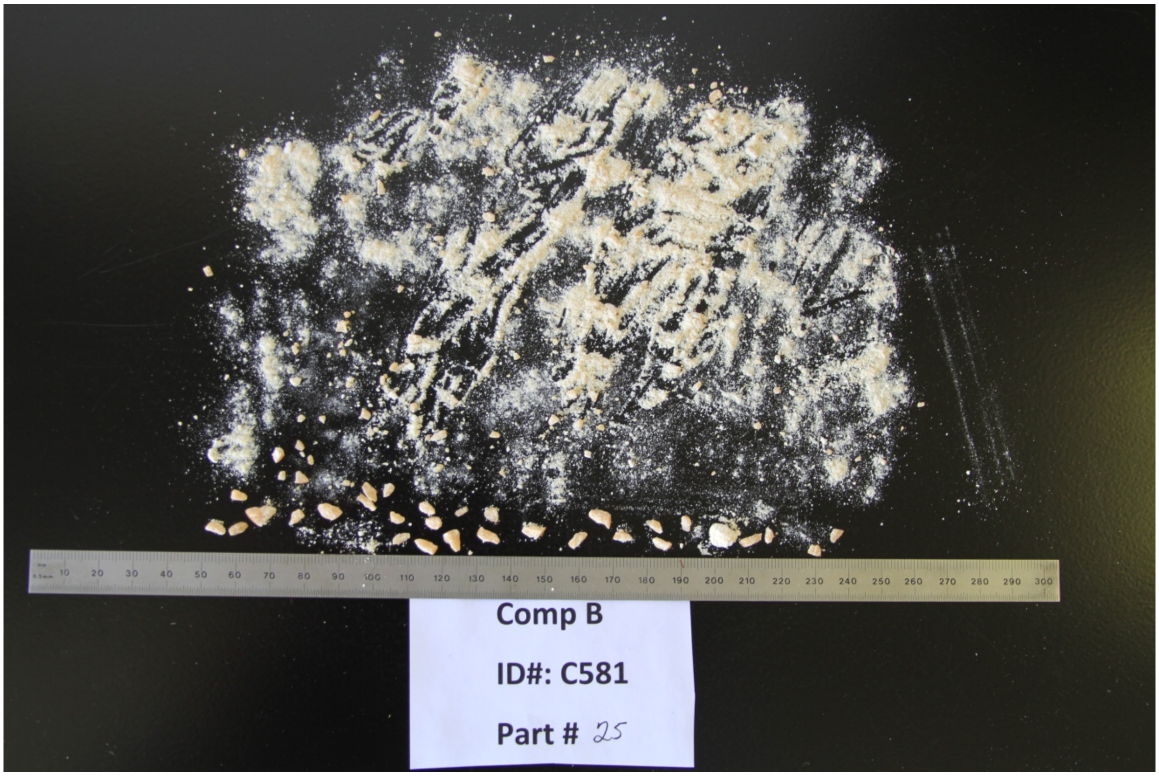
Part # 24


Comp B
ID#: C581
Part # 25


Comp B
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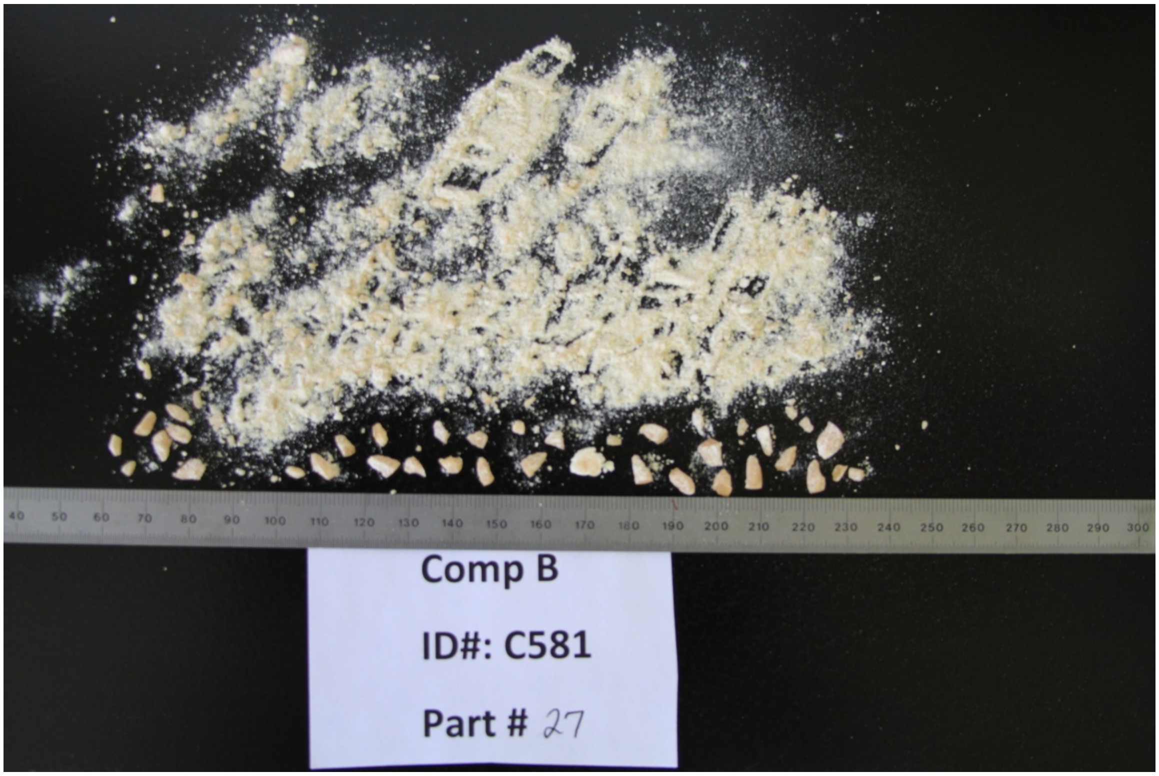
Part # 26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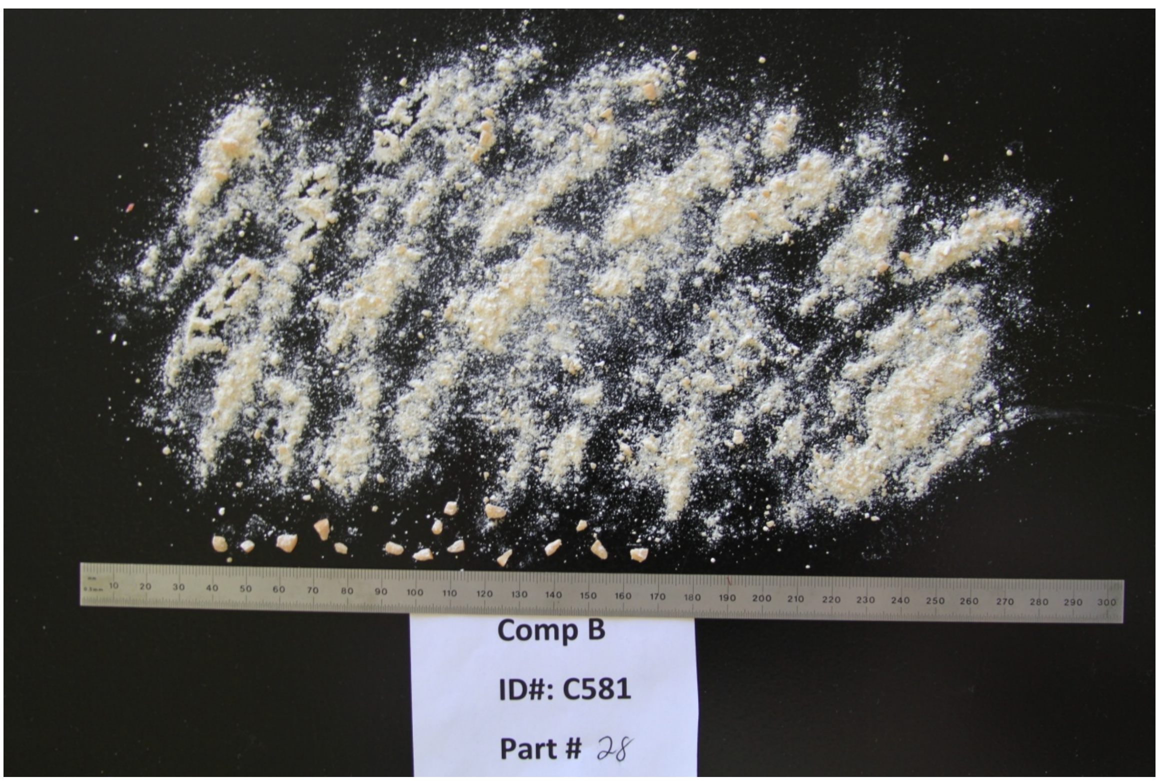
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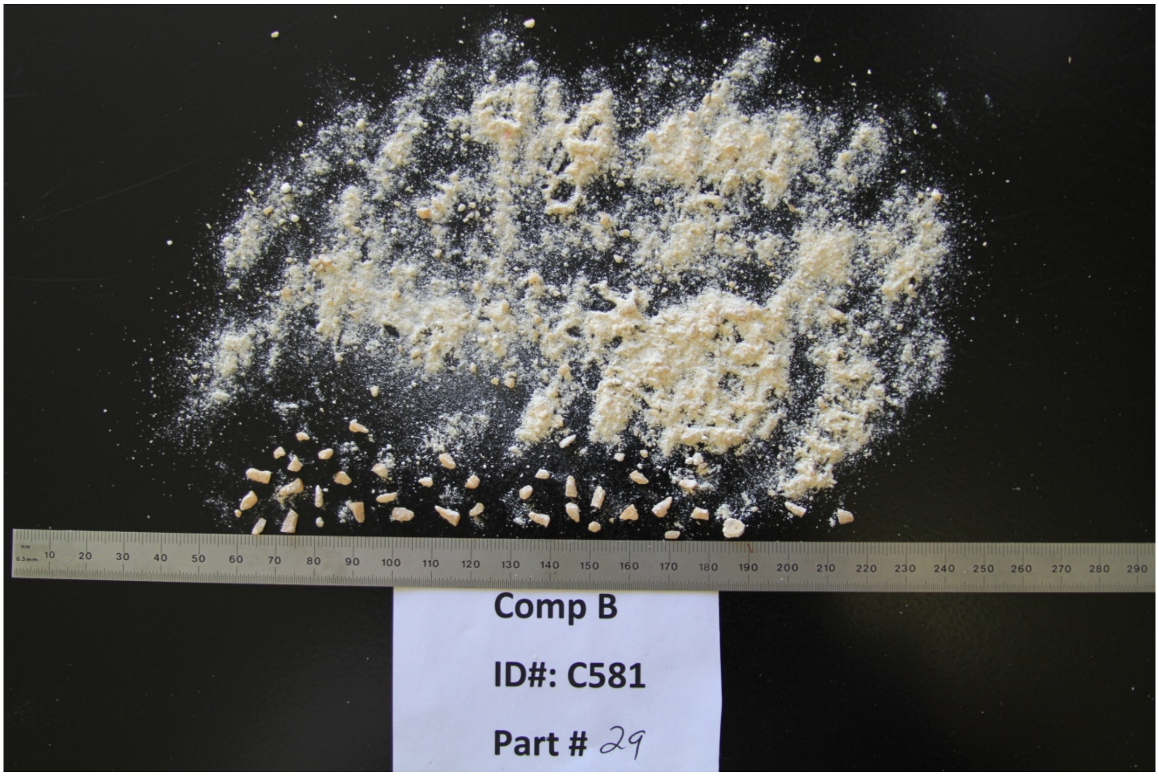
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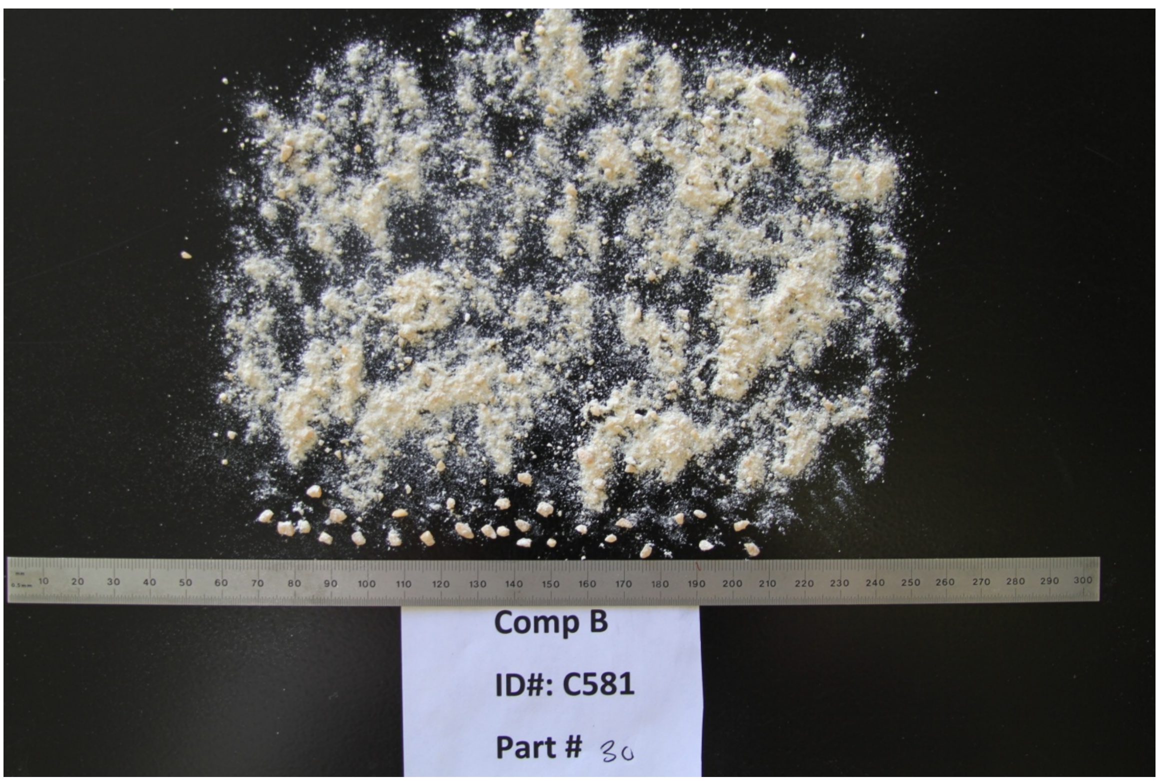
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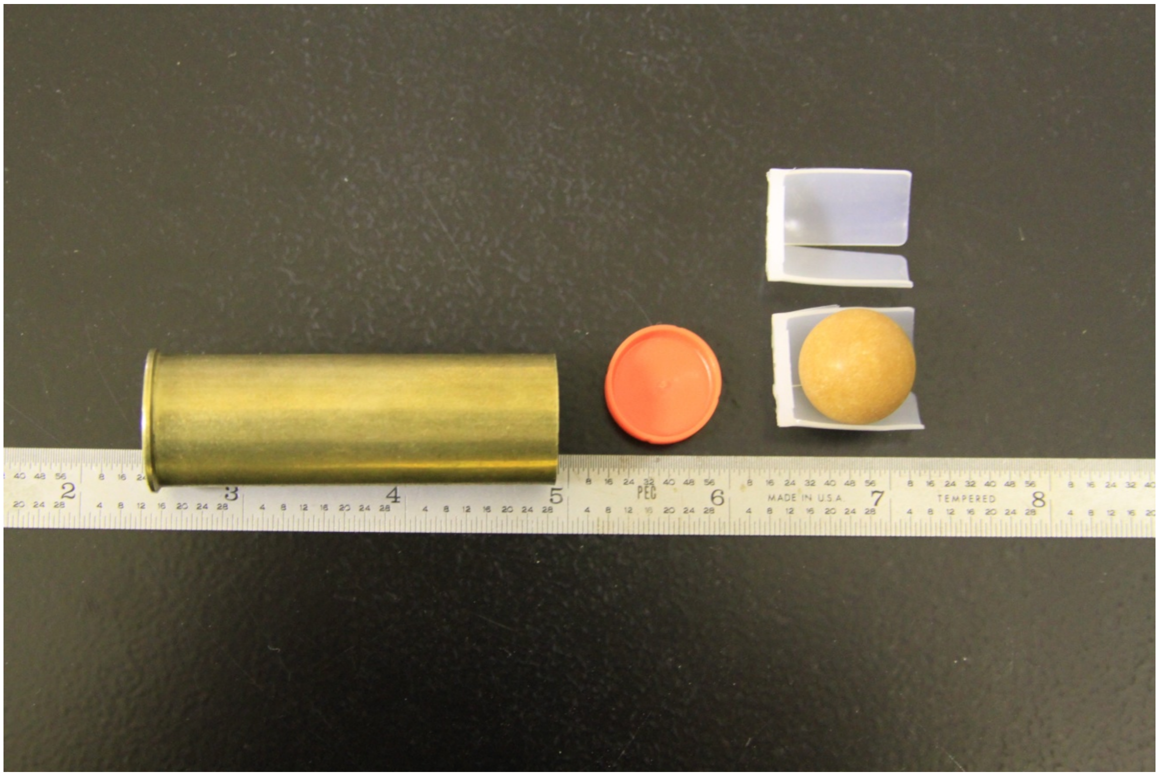
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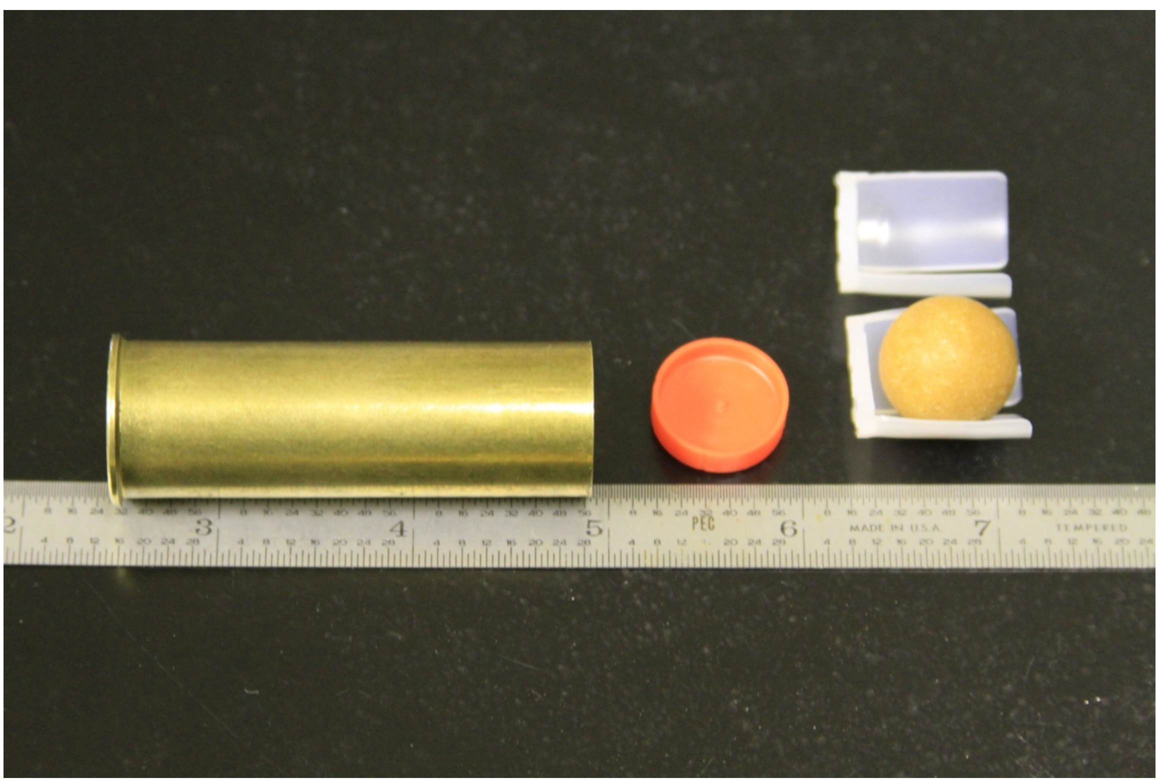
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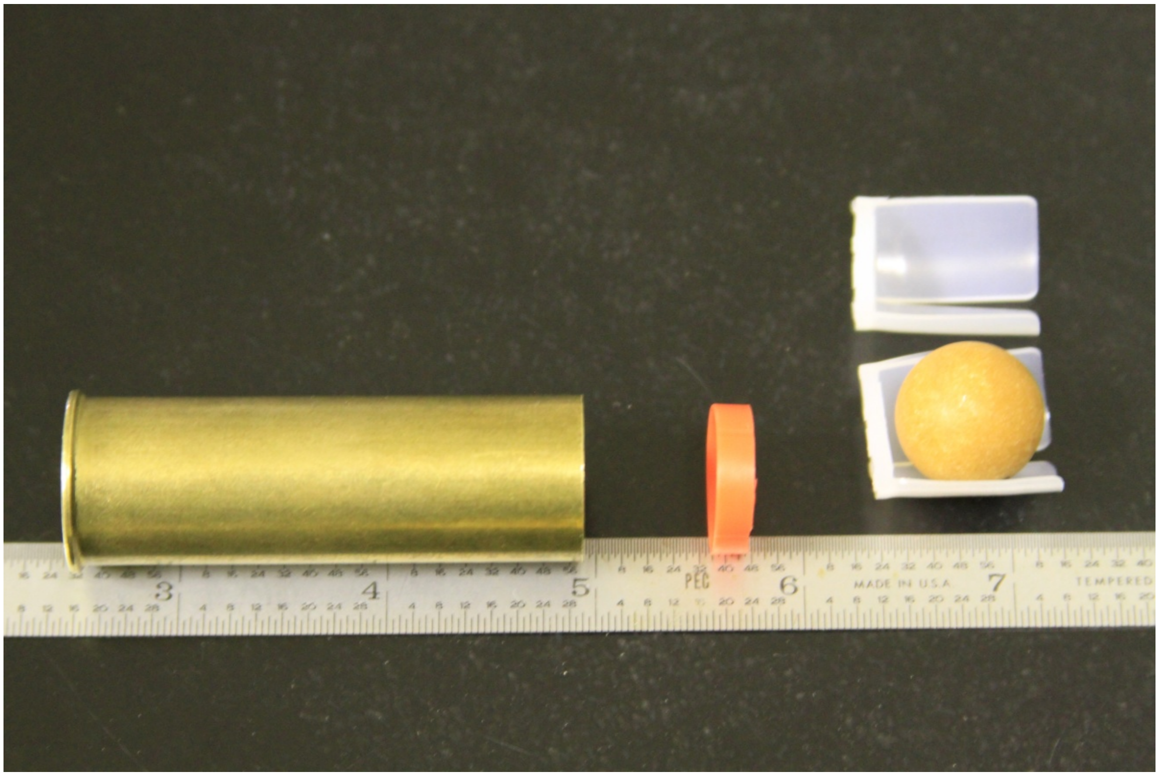
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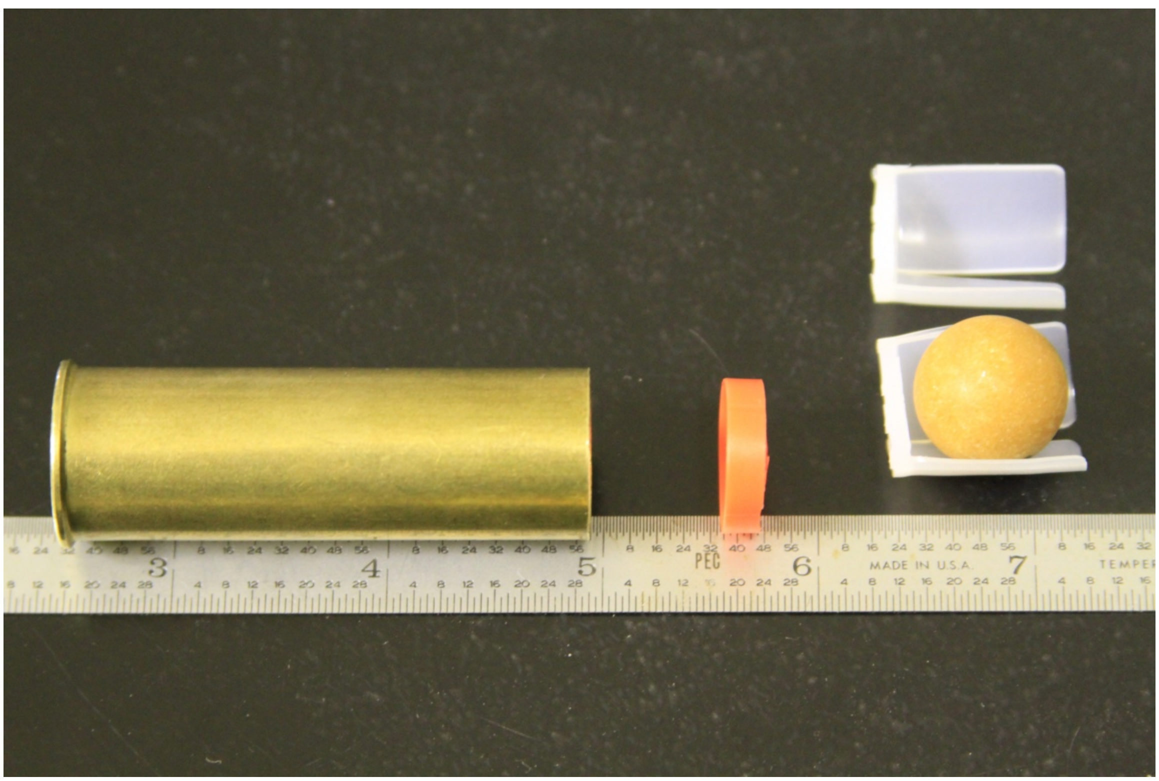
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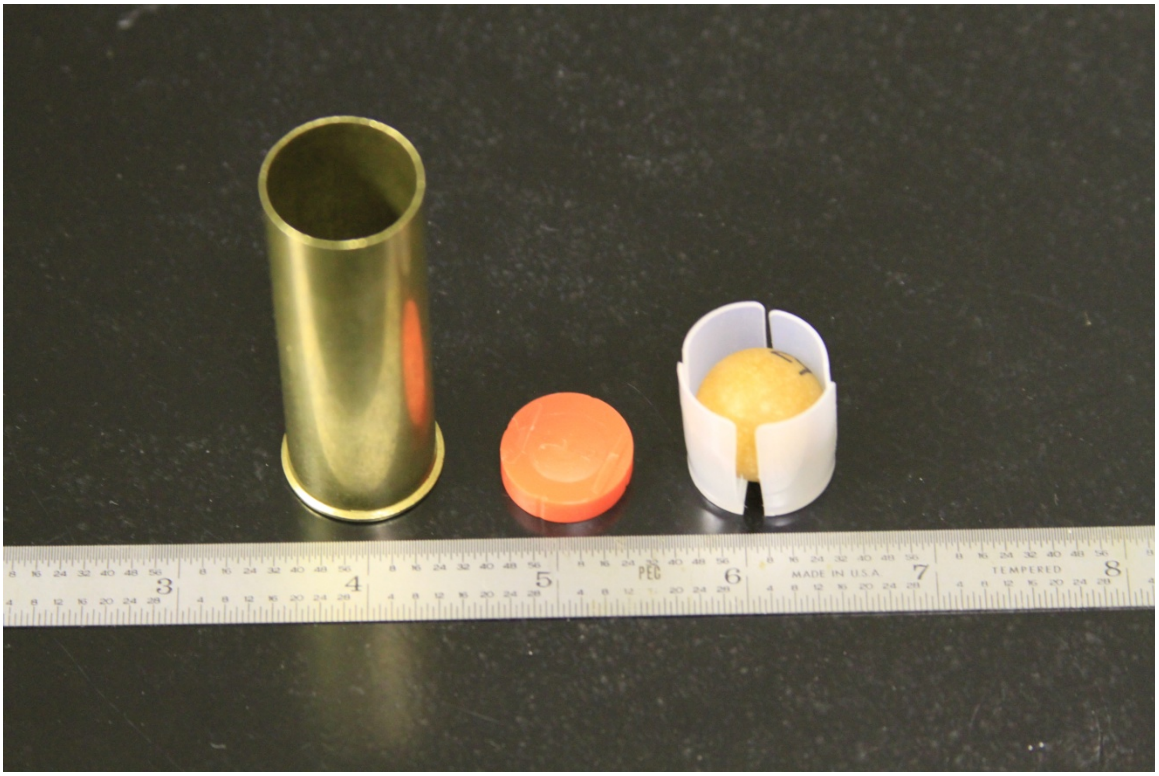
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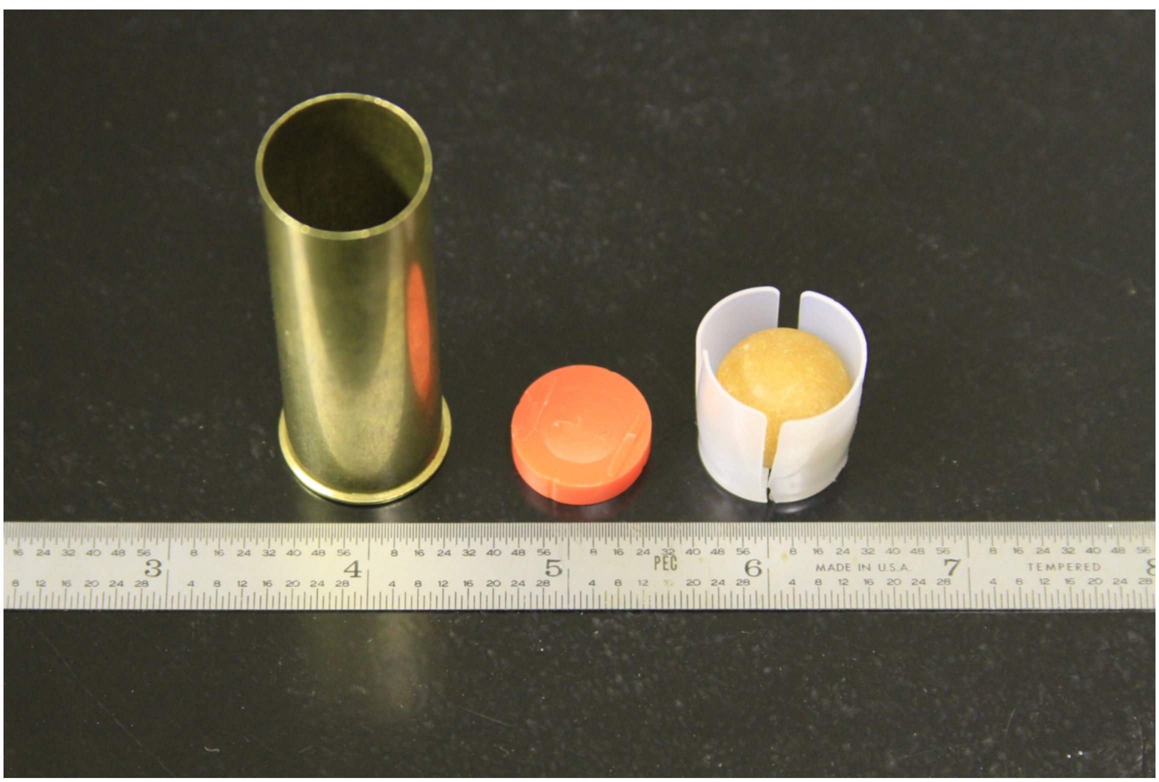
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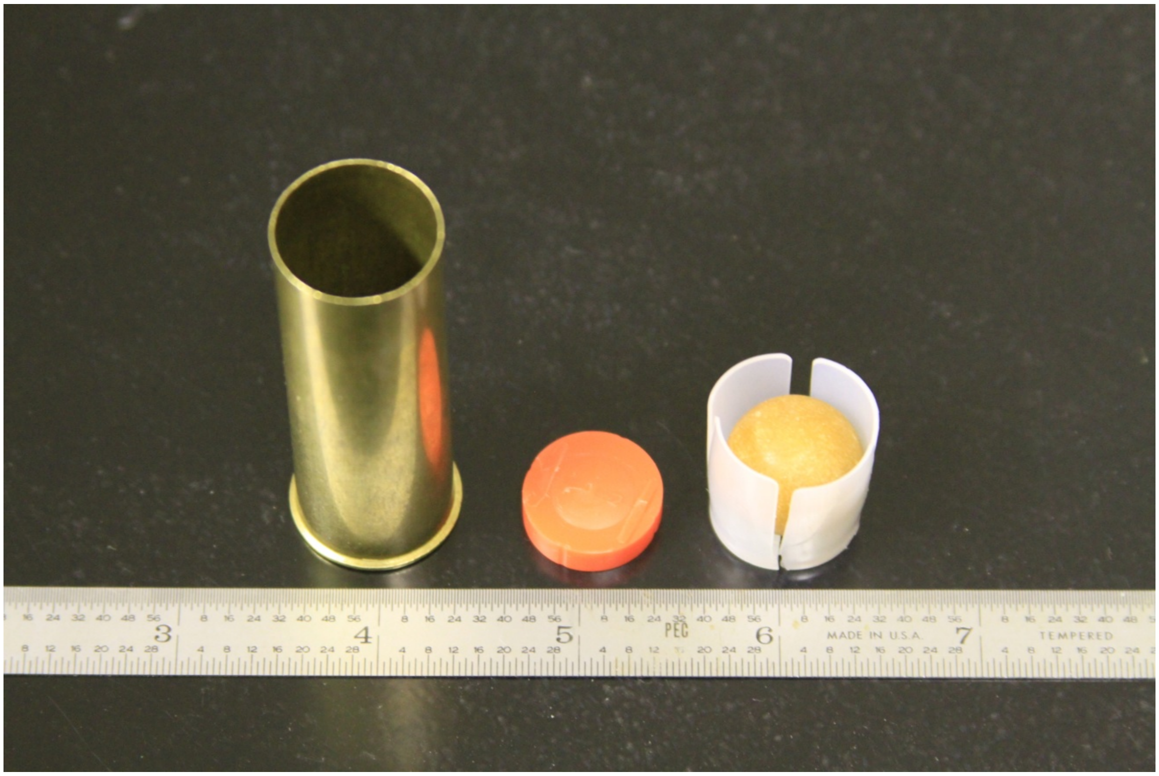
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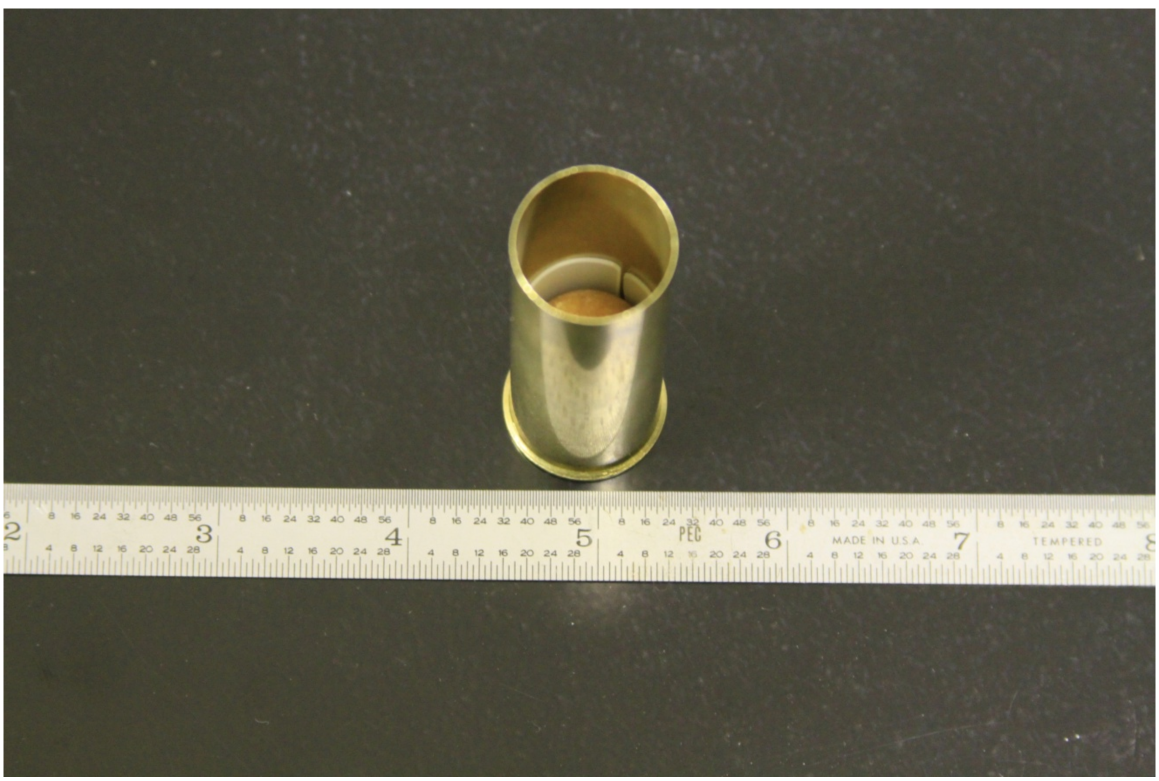
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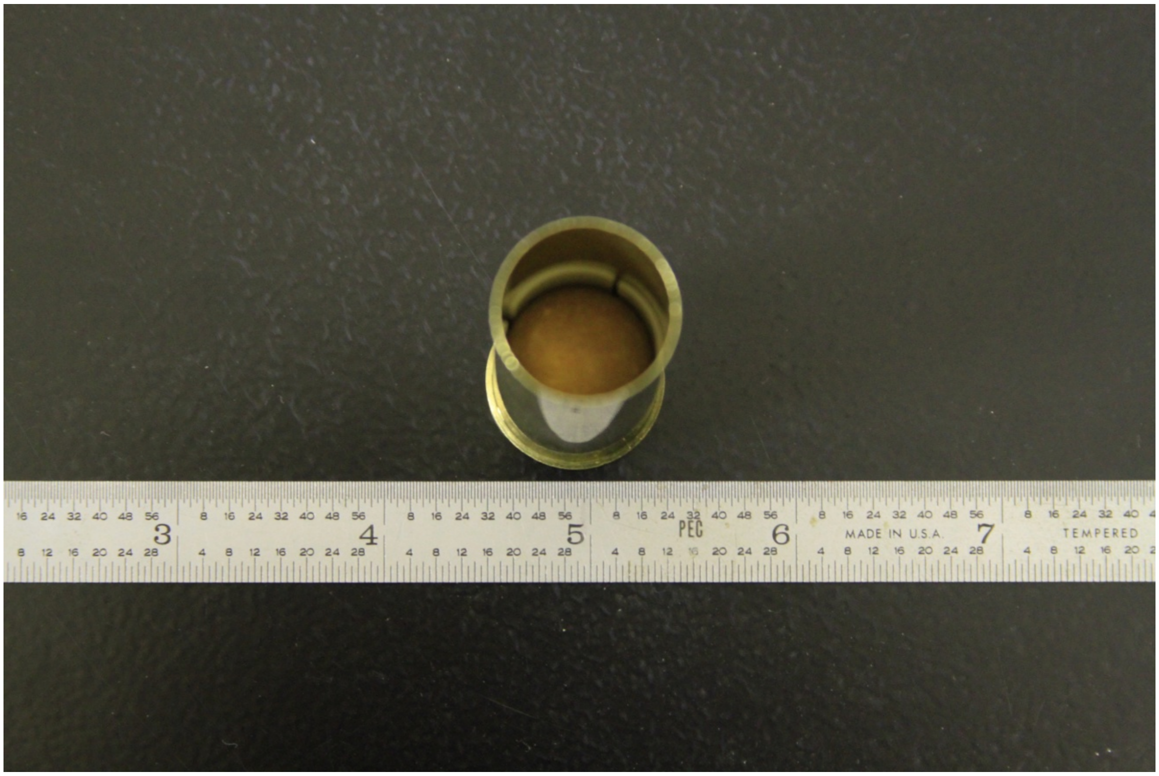
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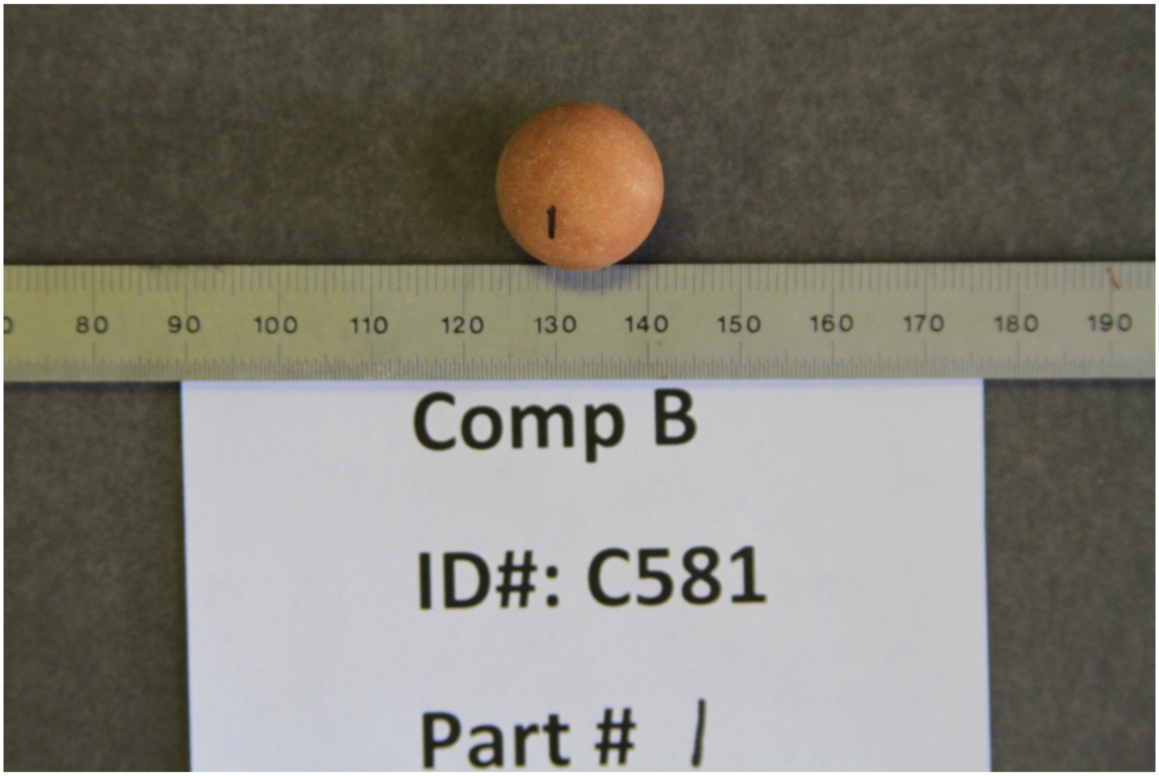
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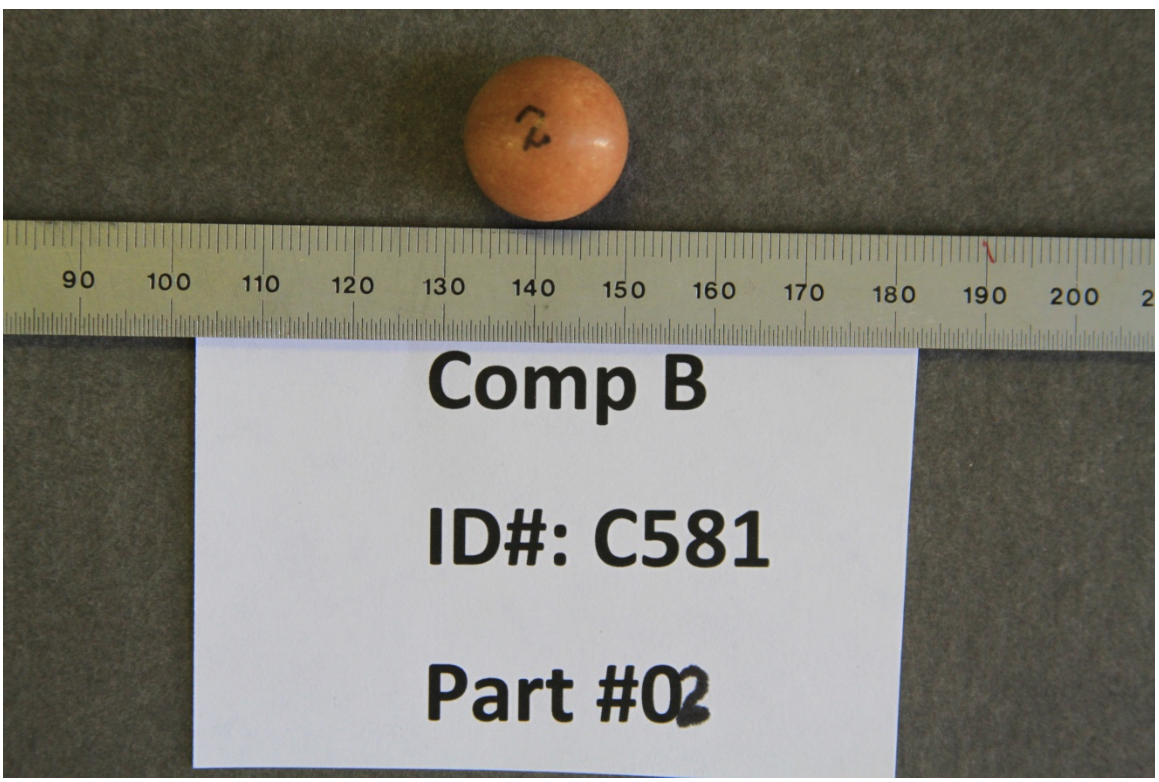
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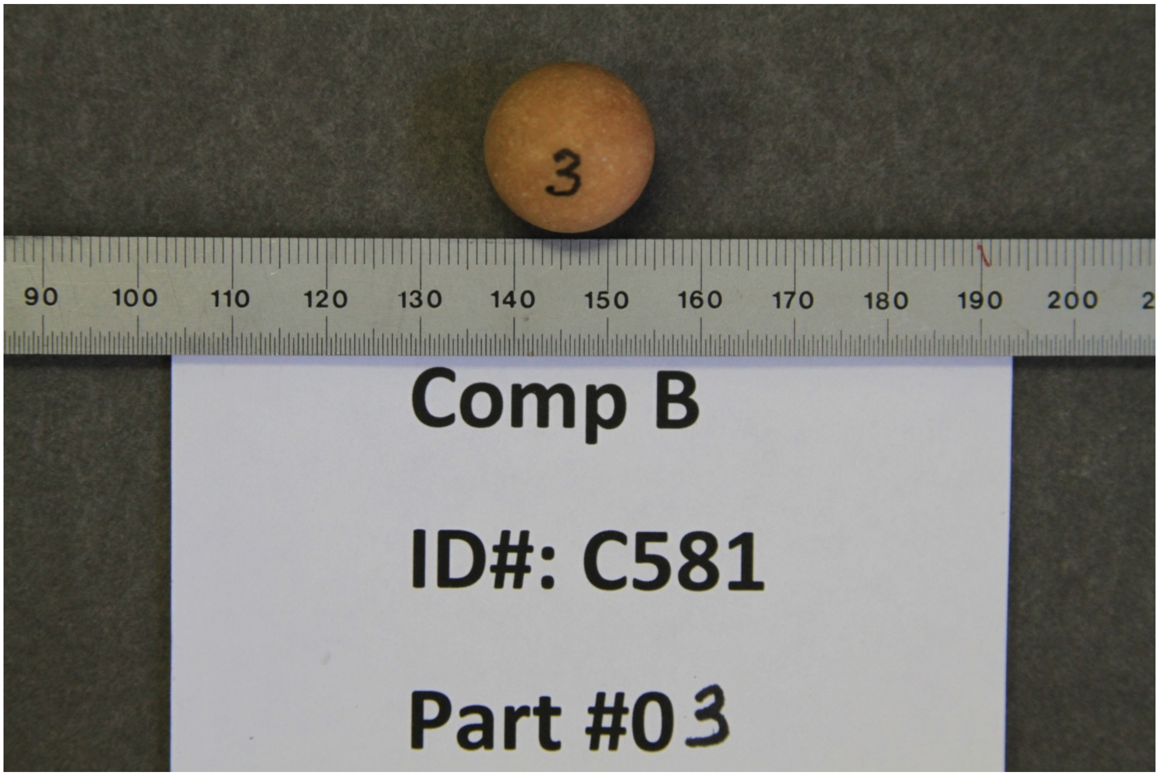
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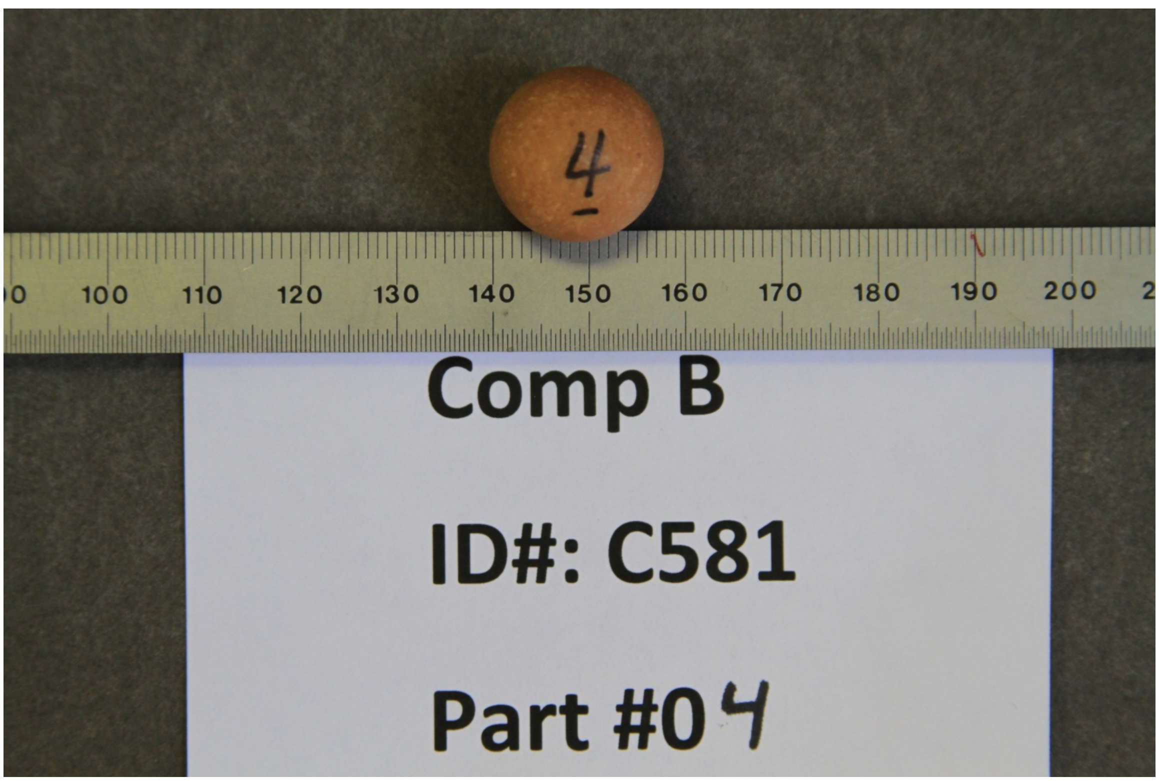
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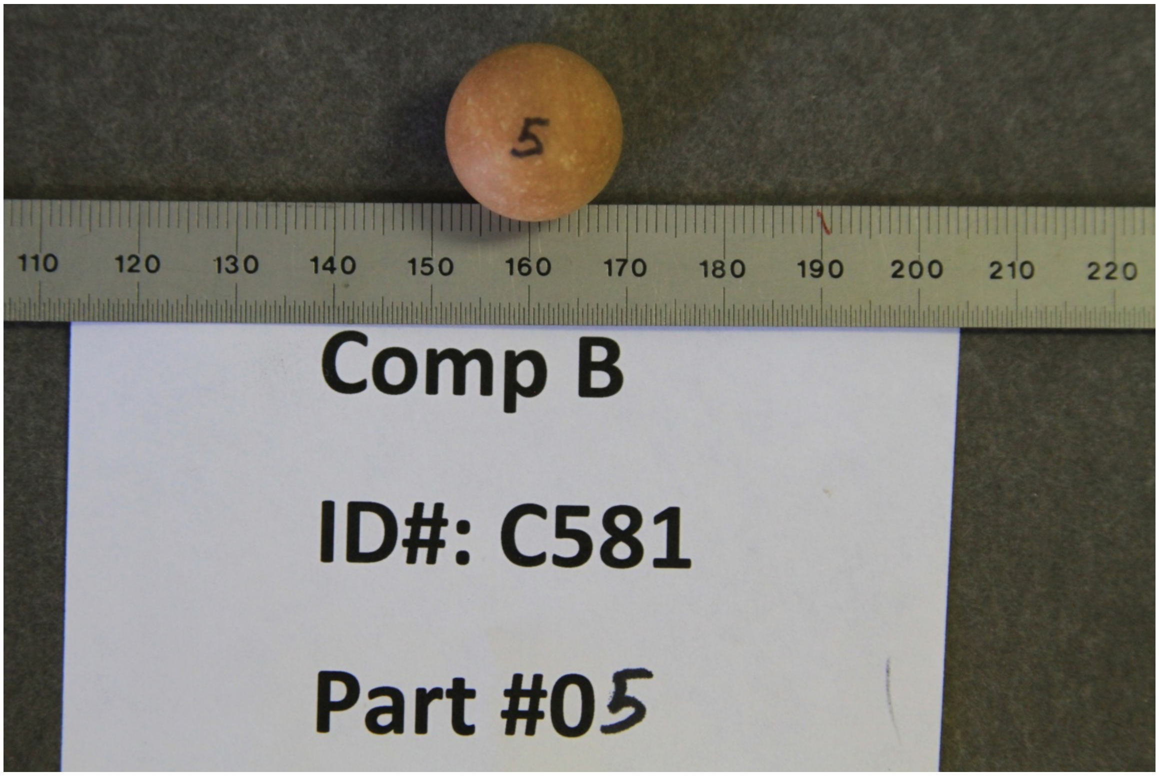
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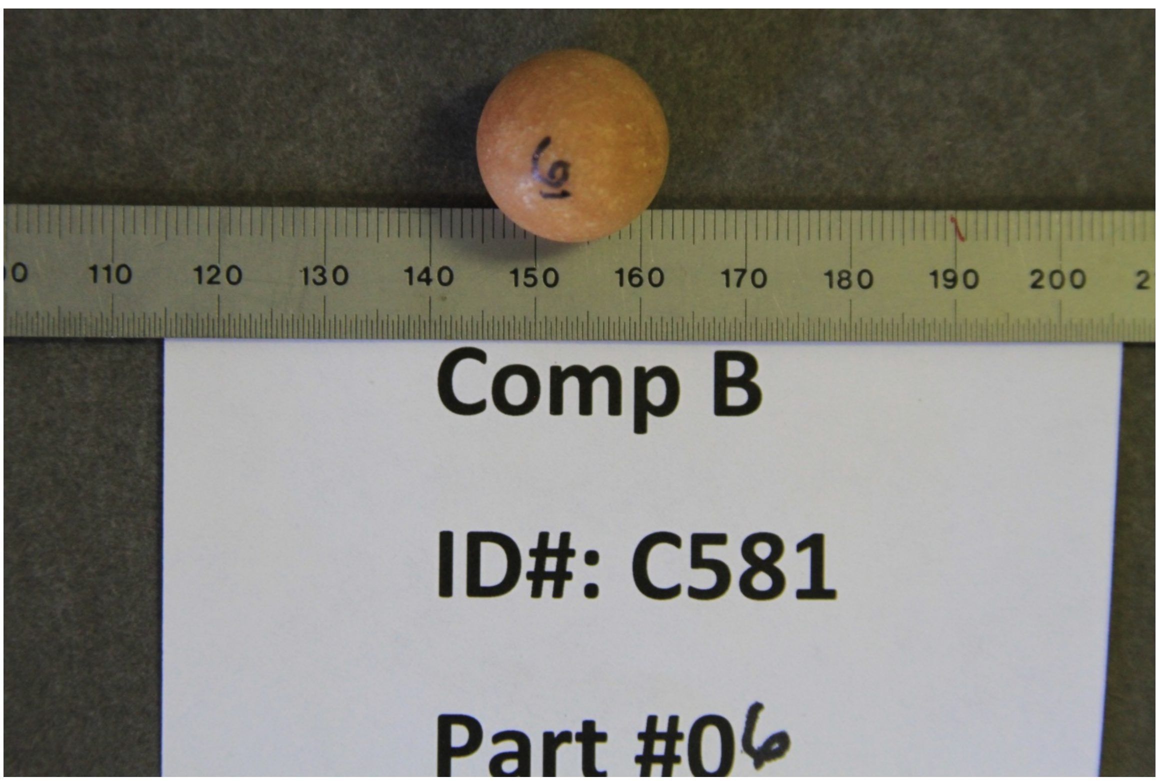
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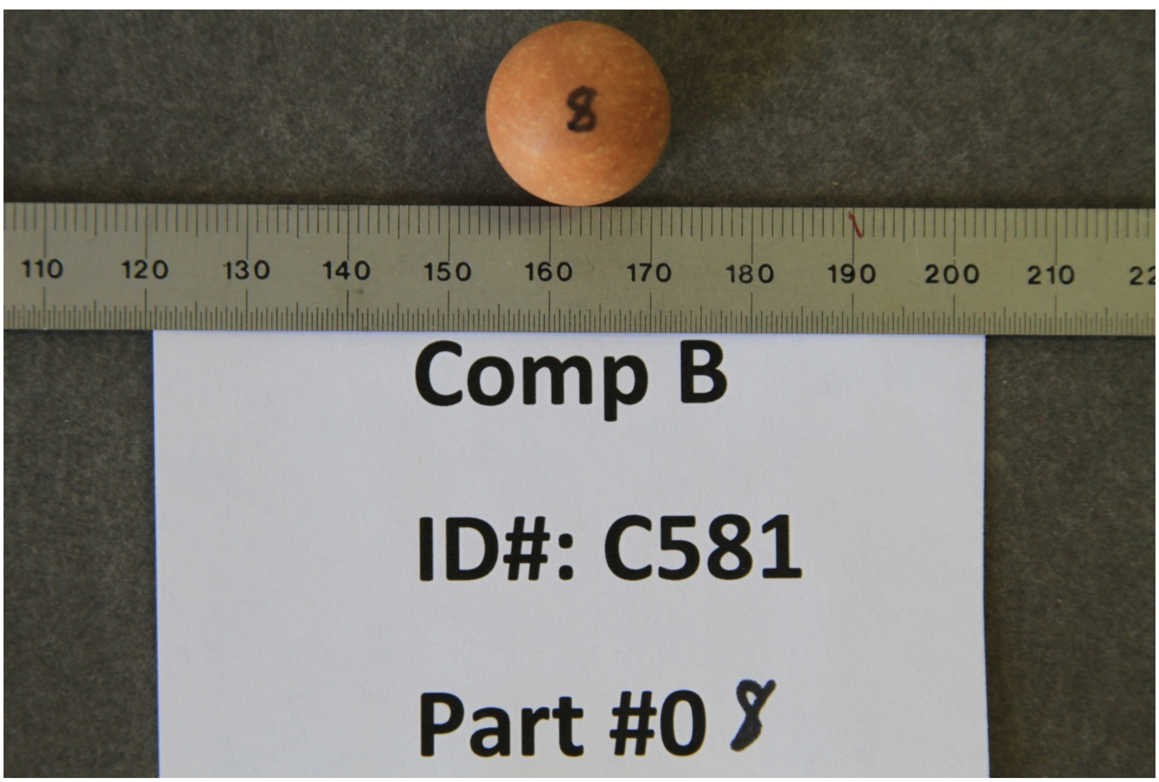
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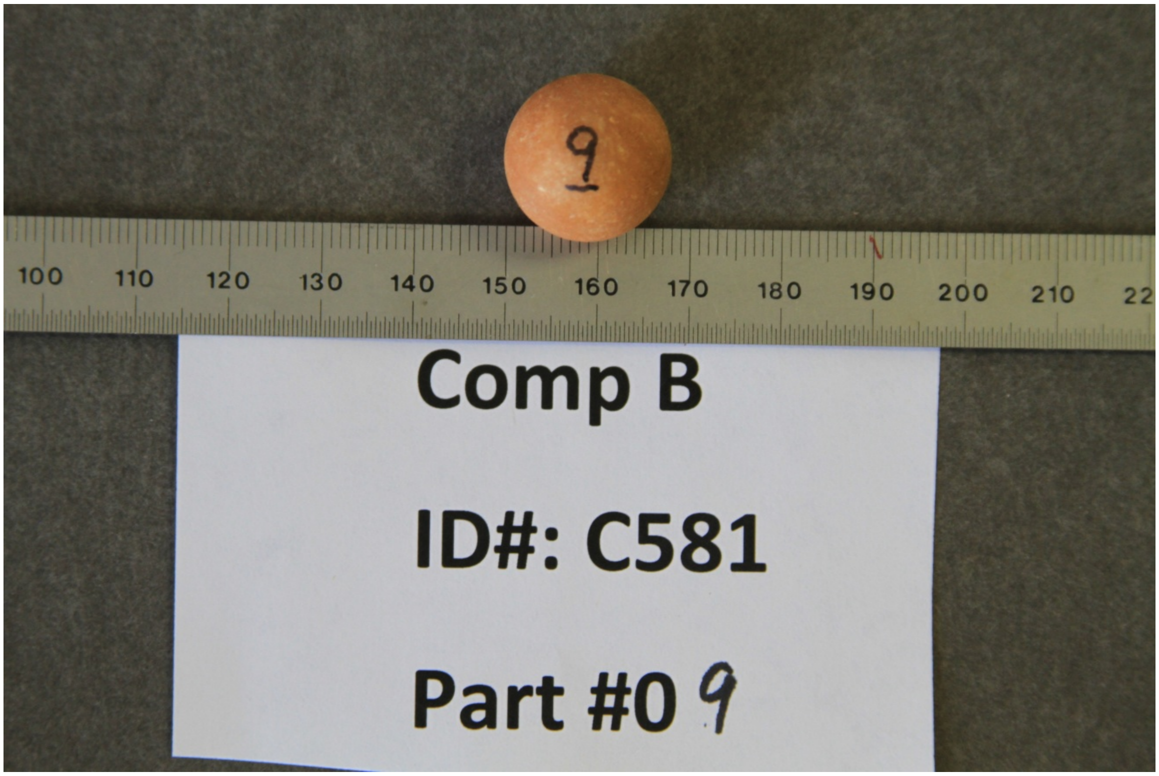
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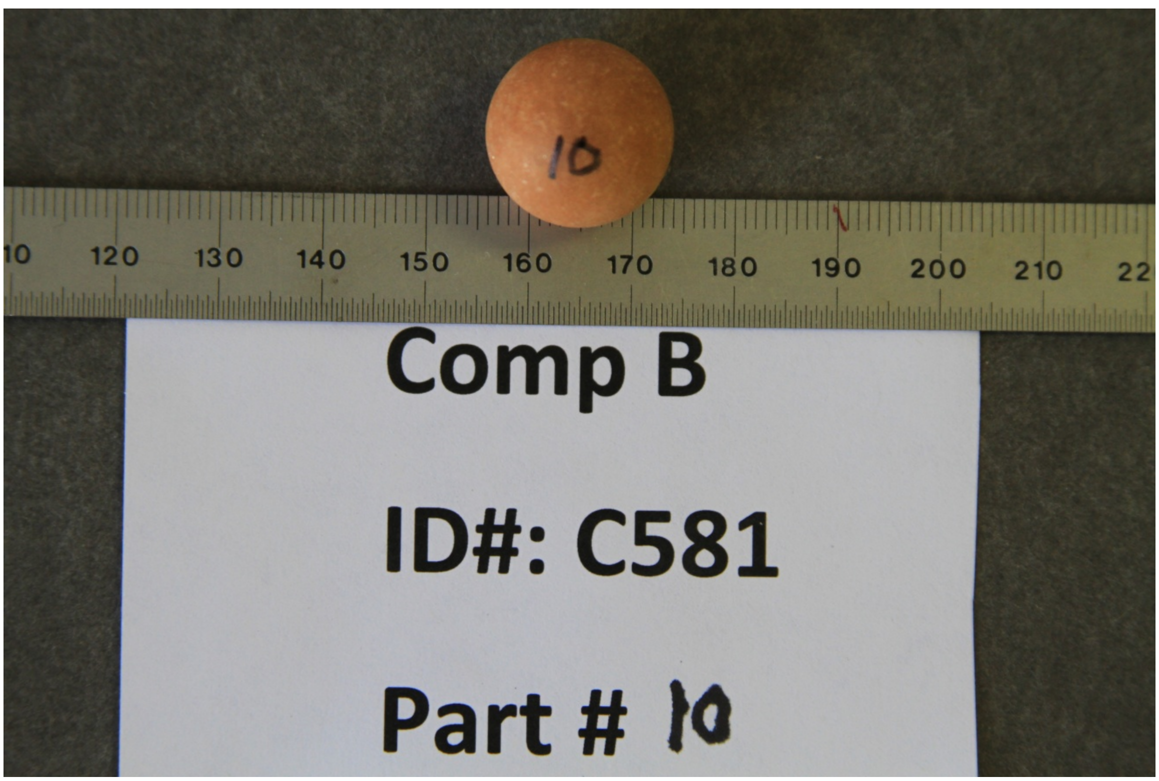
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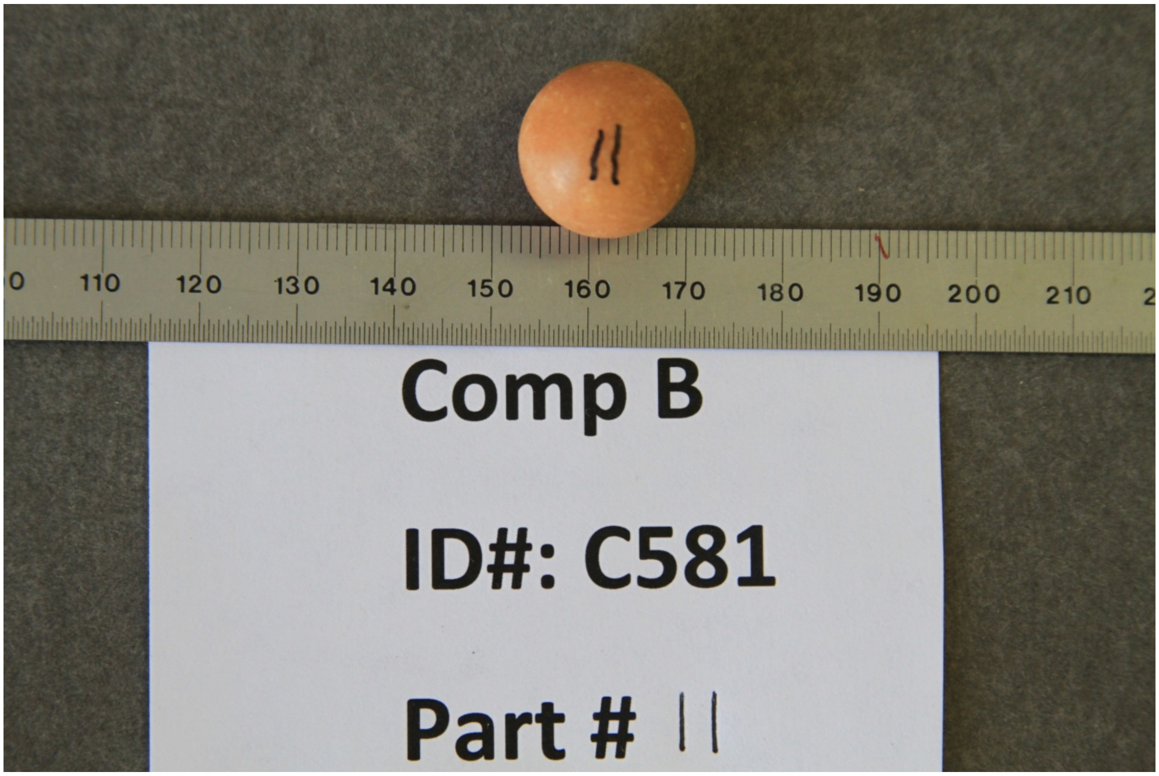
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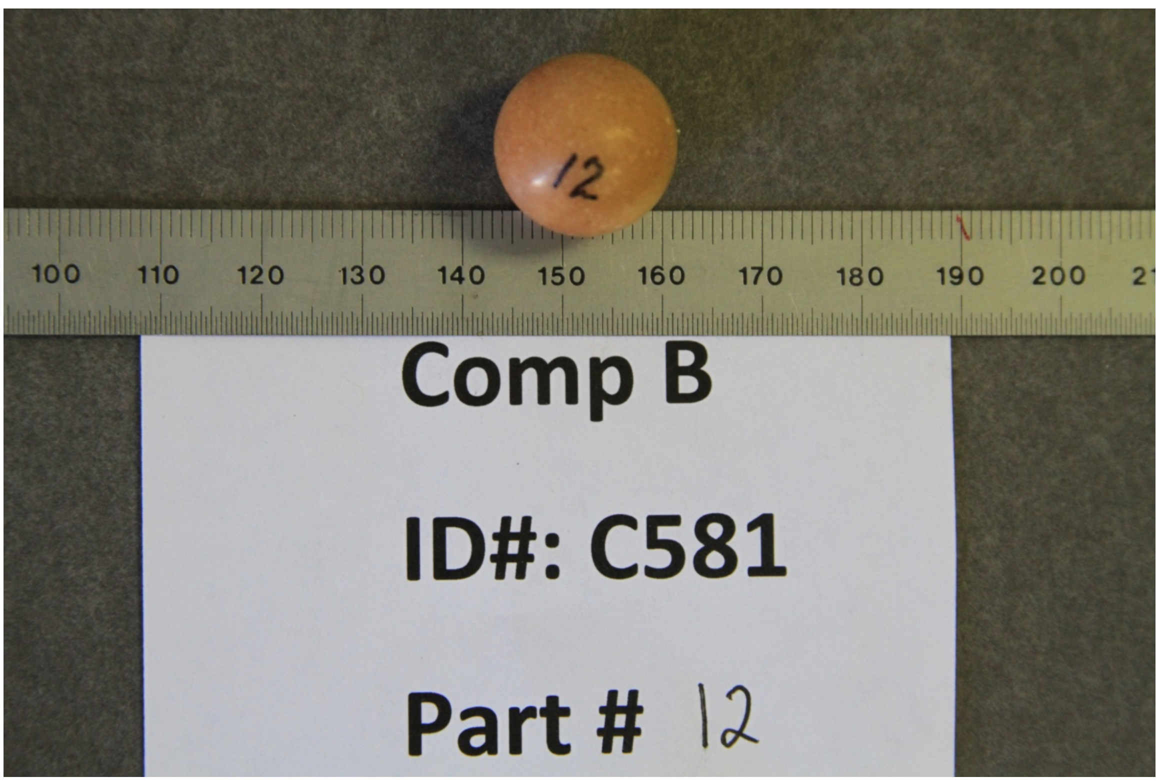
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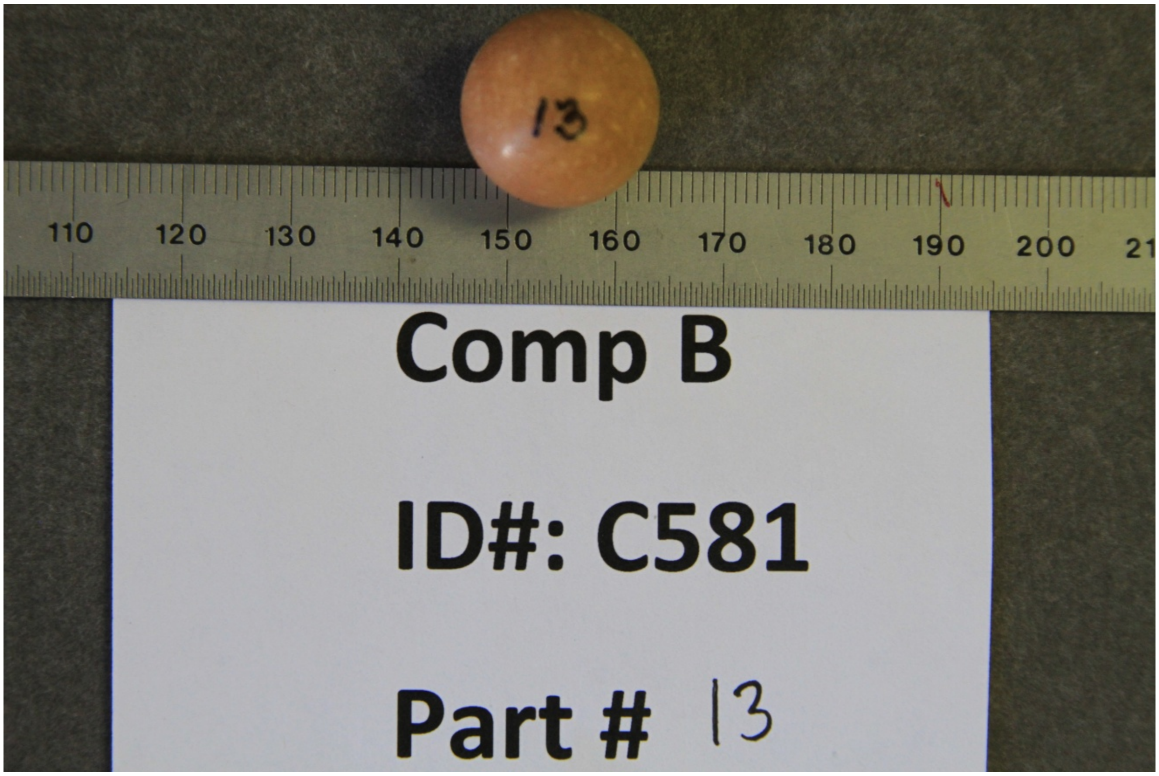
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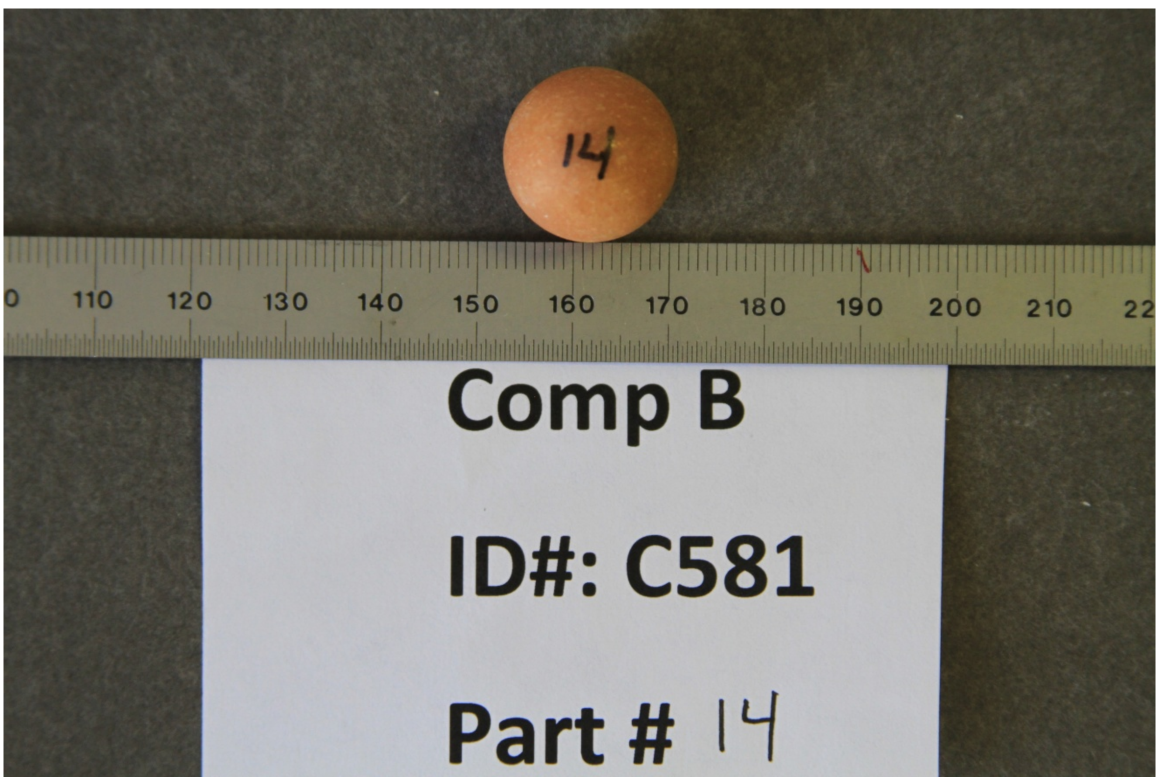
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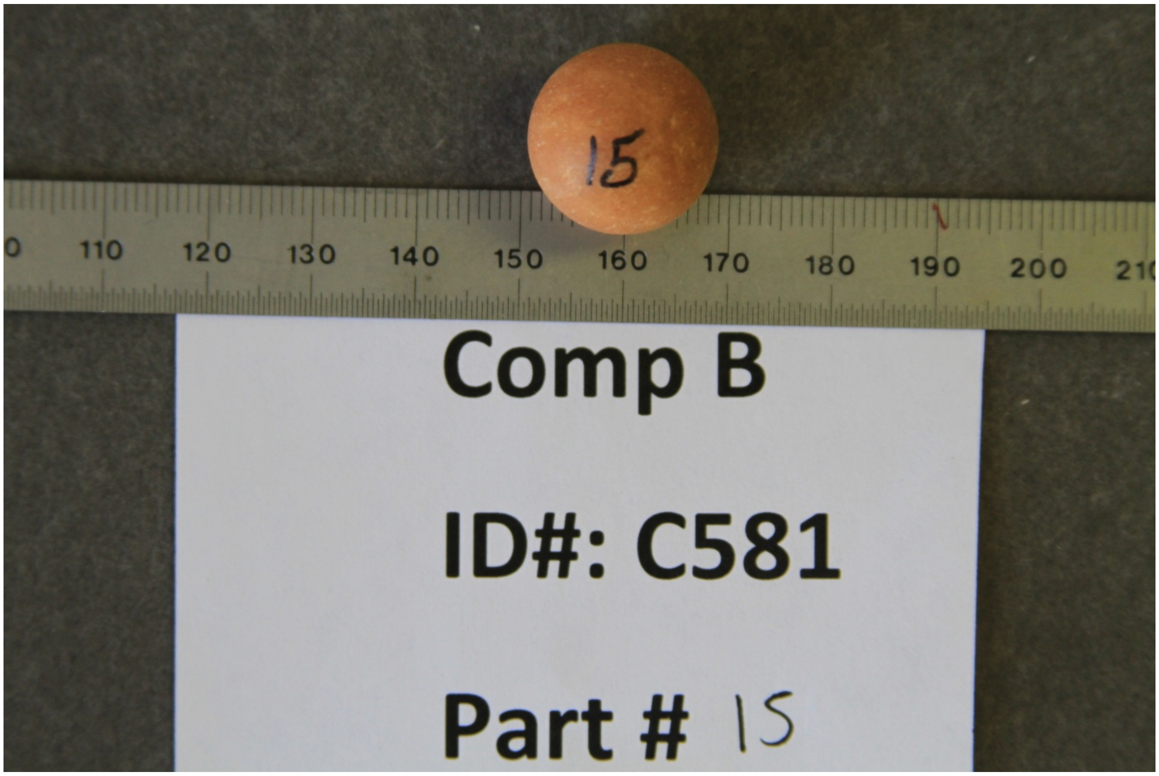
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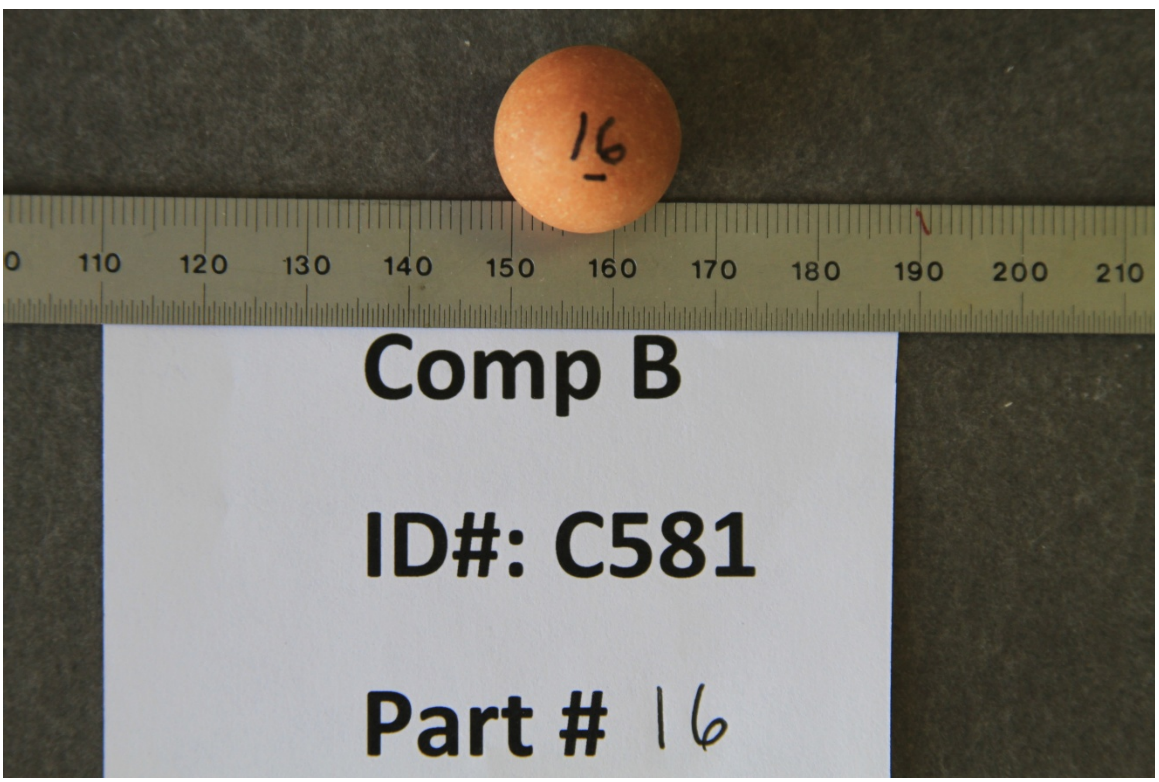
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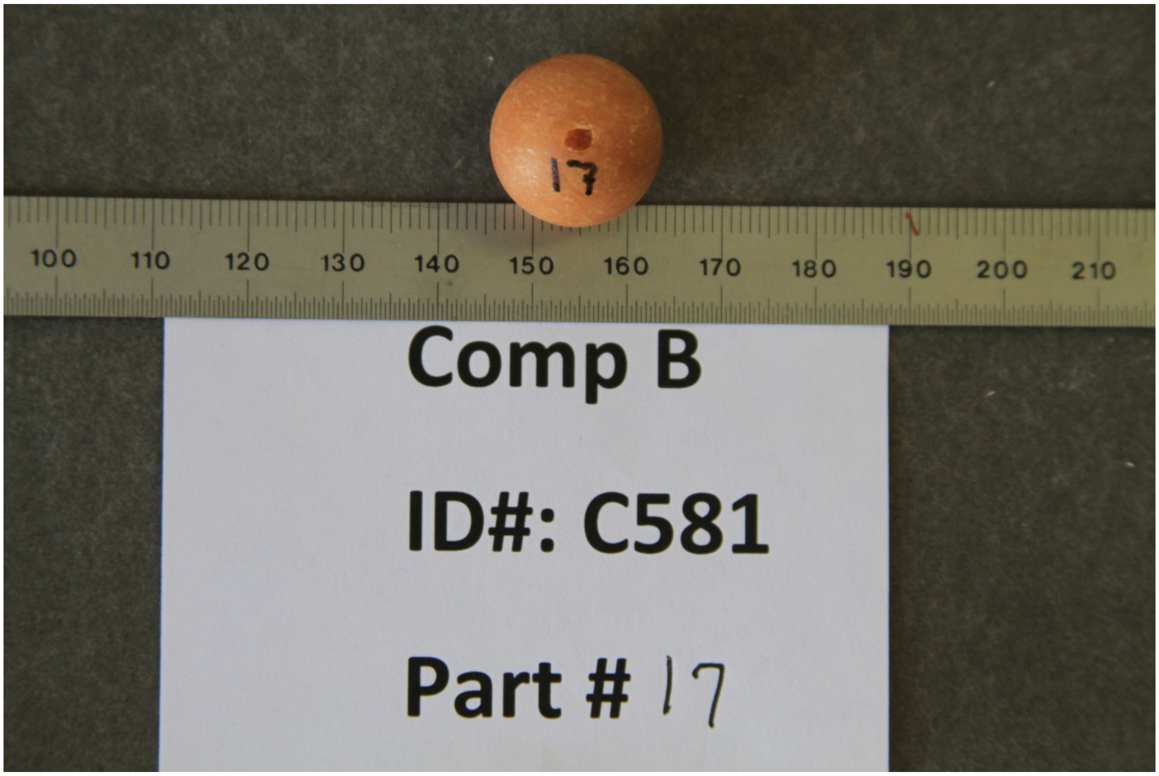
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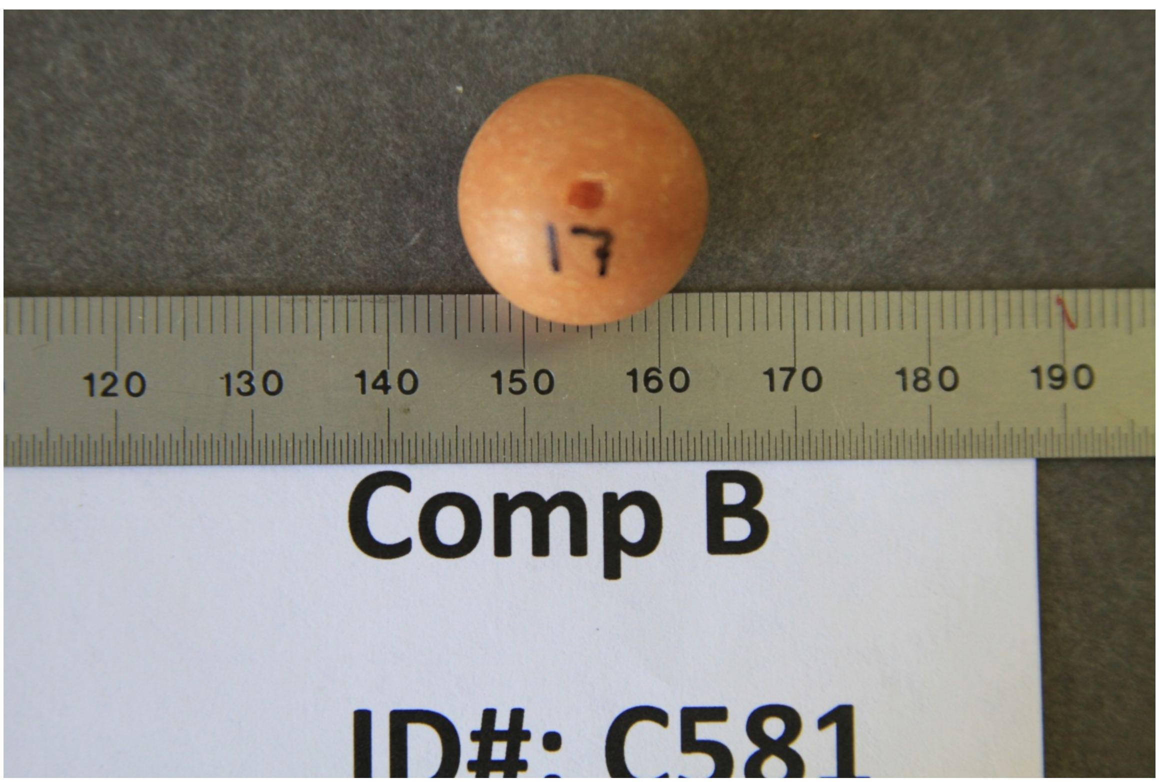
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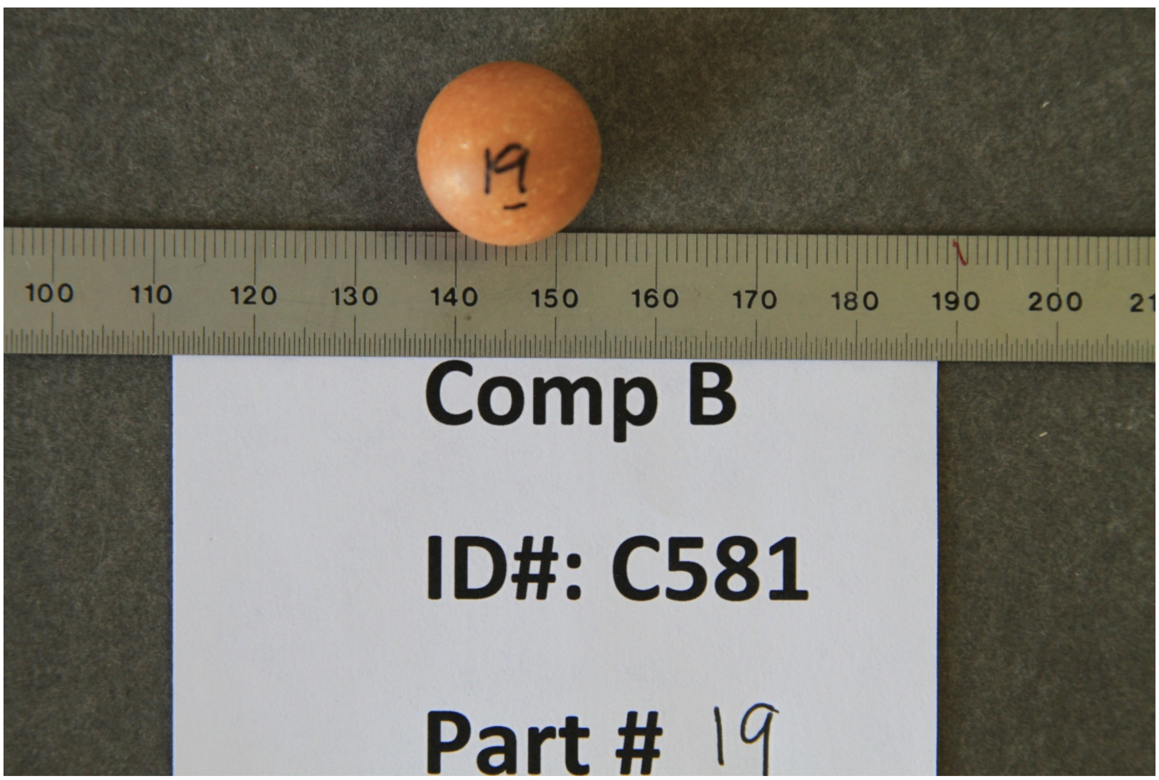
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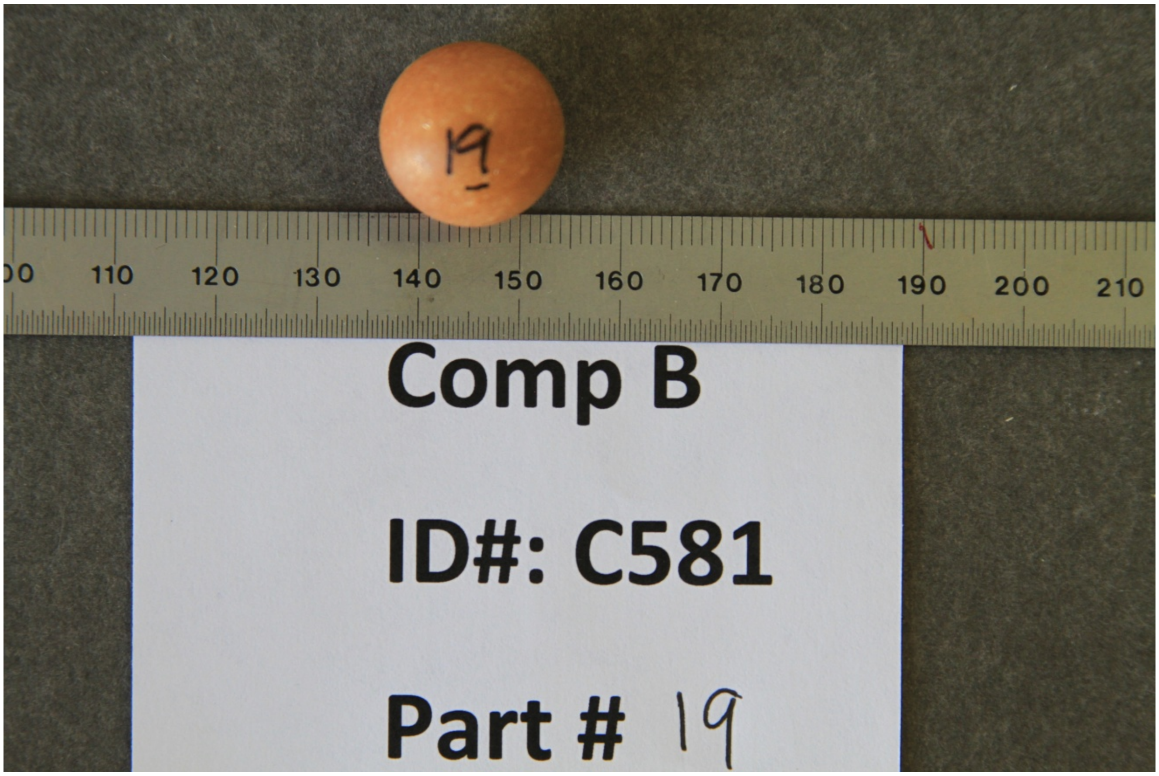
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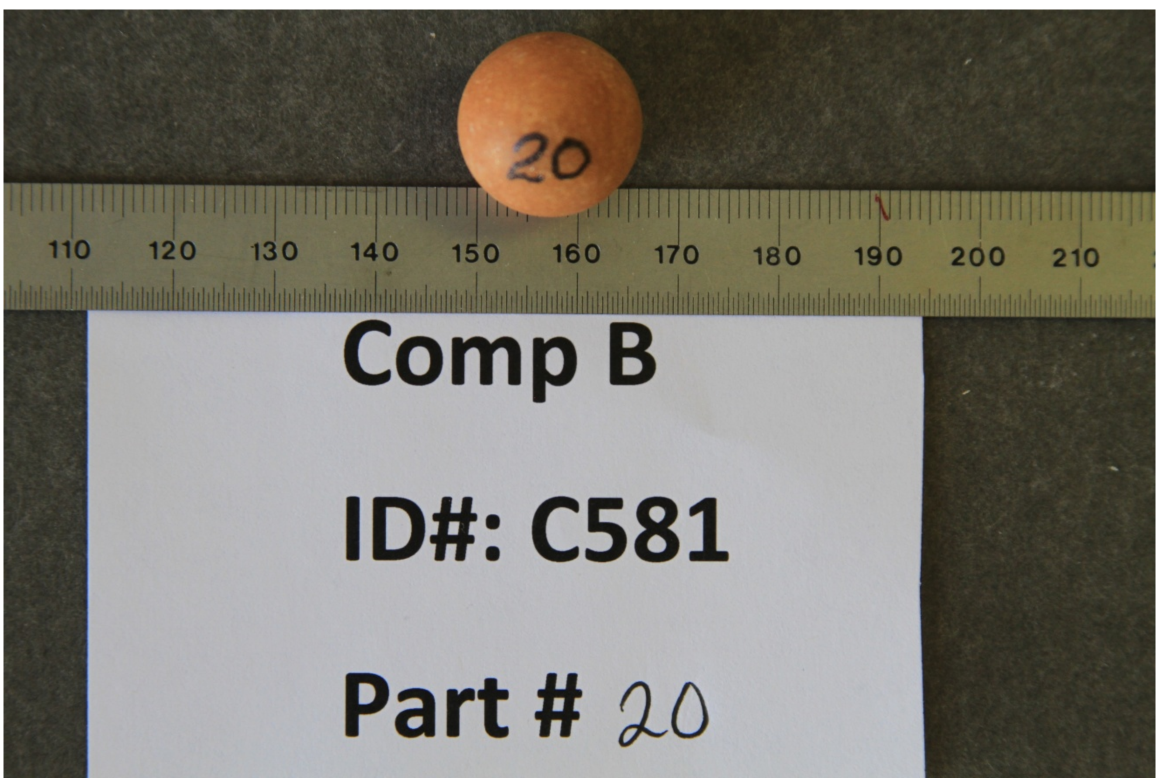
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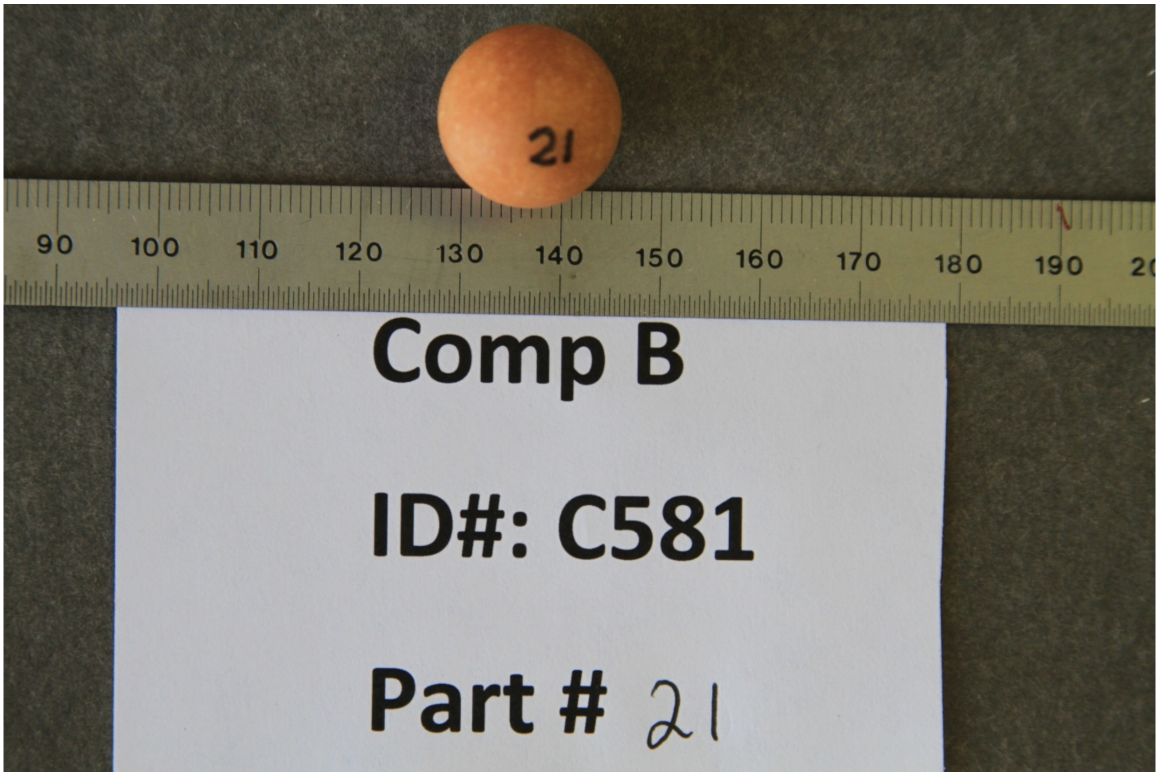
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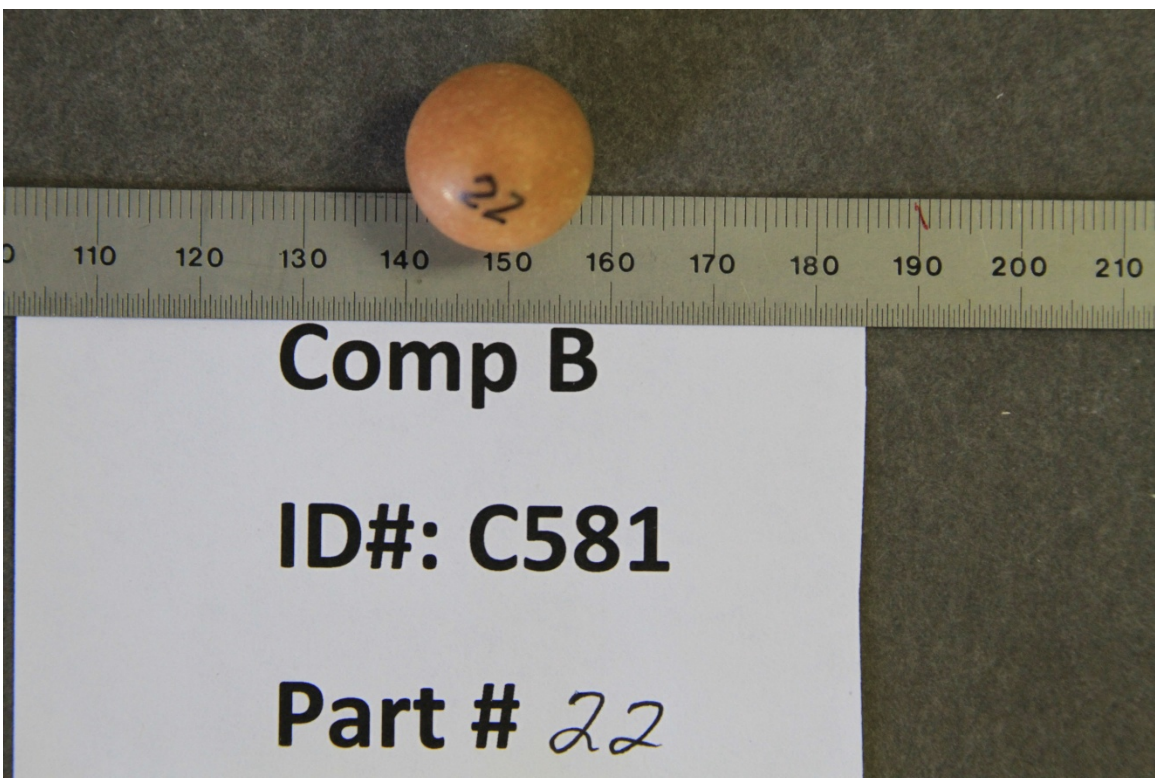
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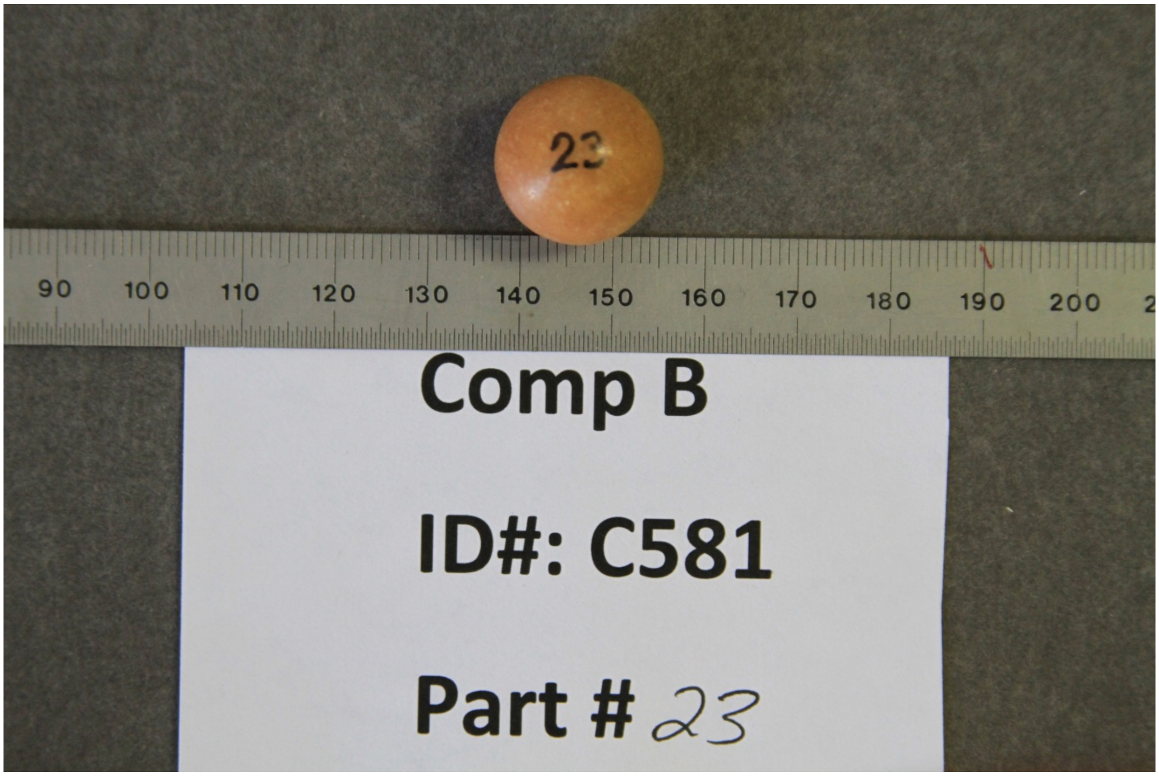
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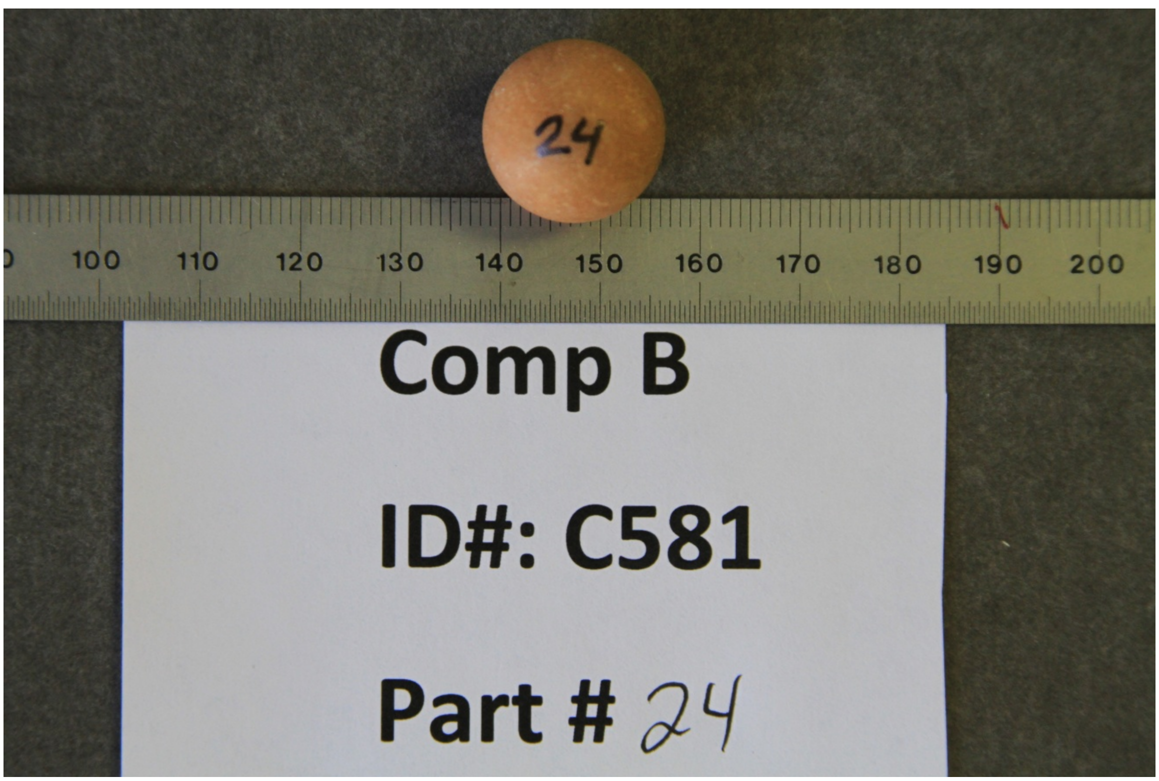
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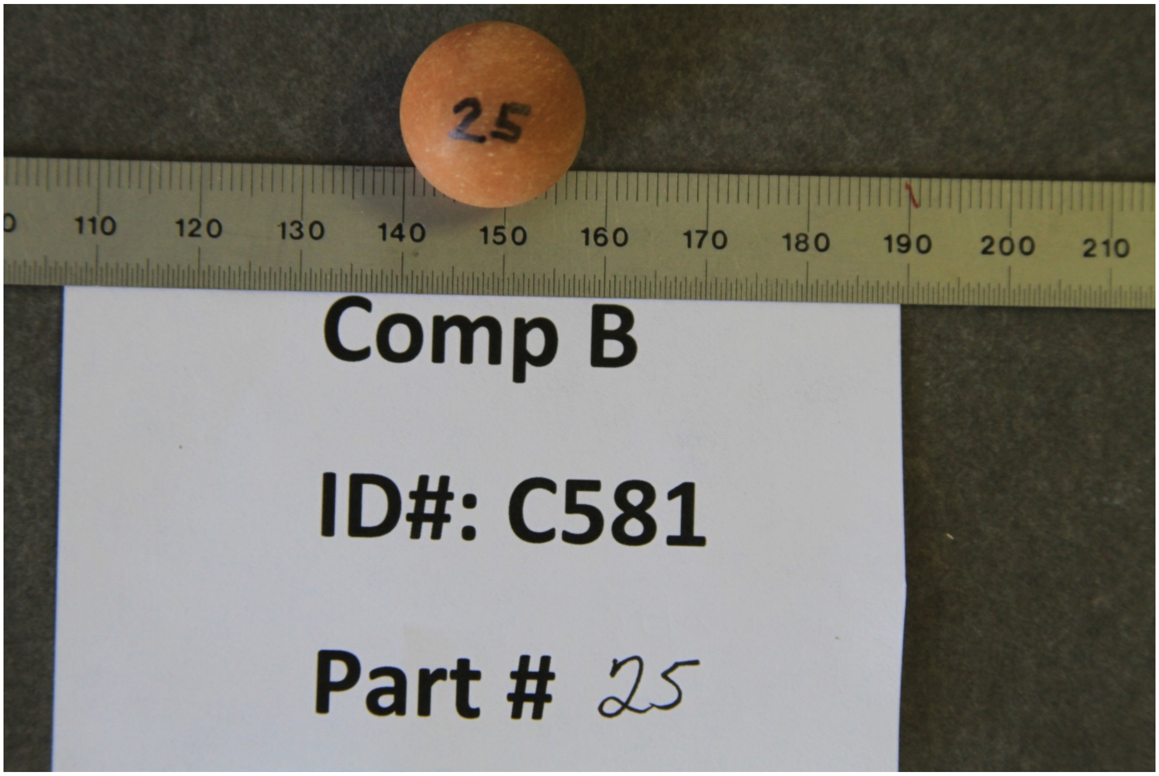
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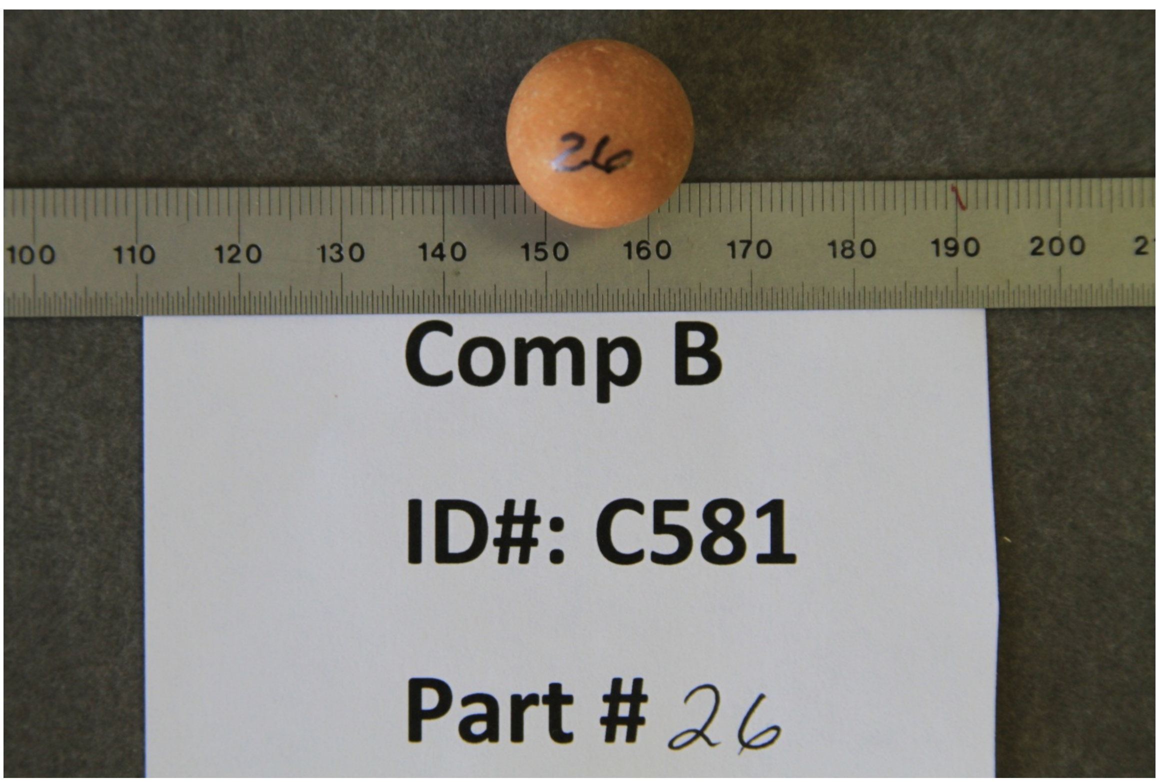
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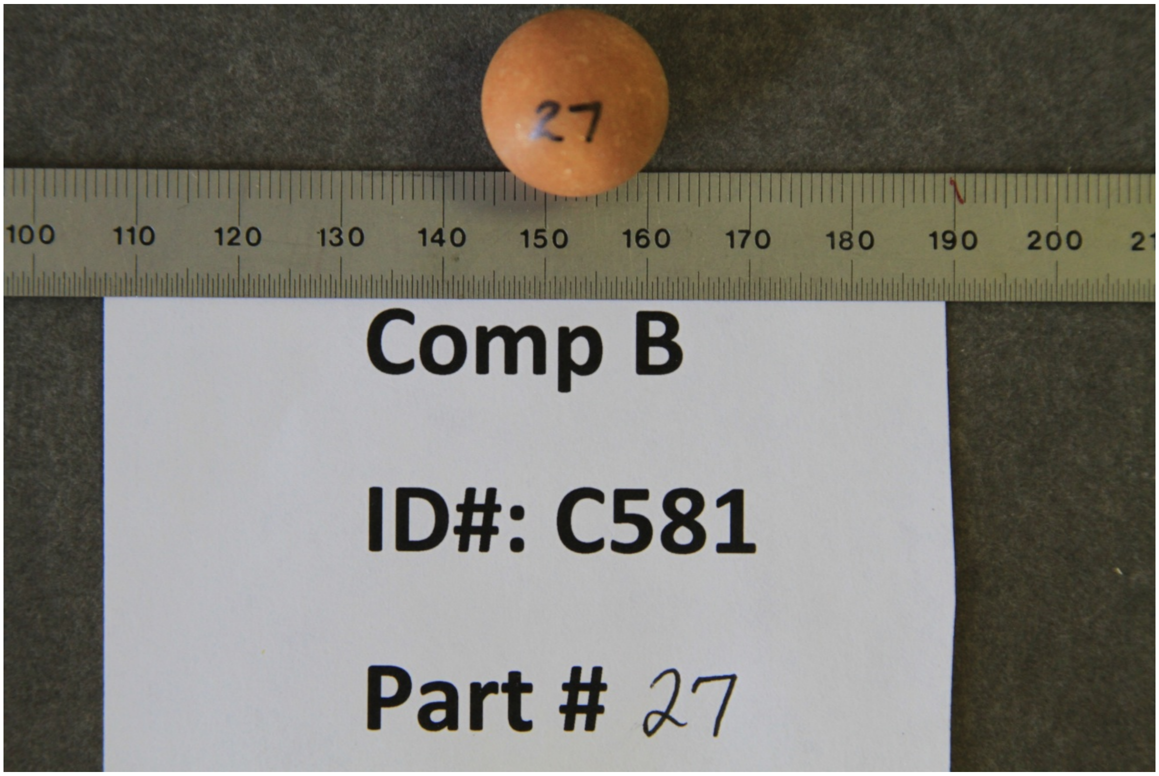
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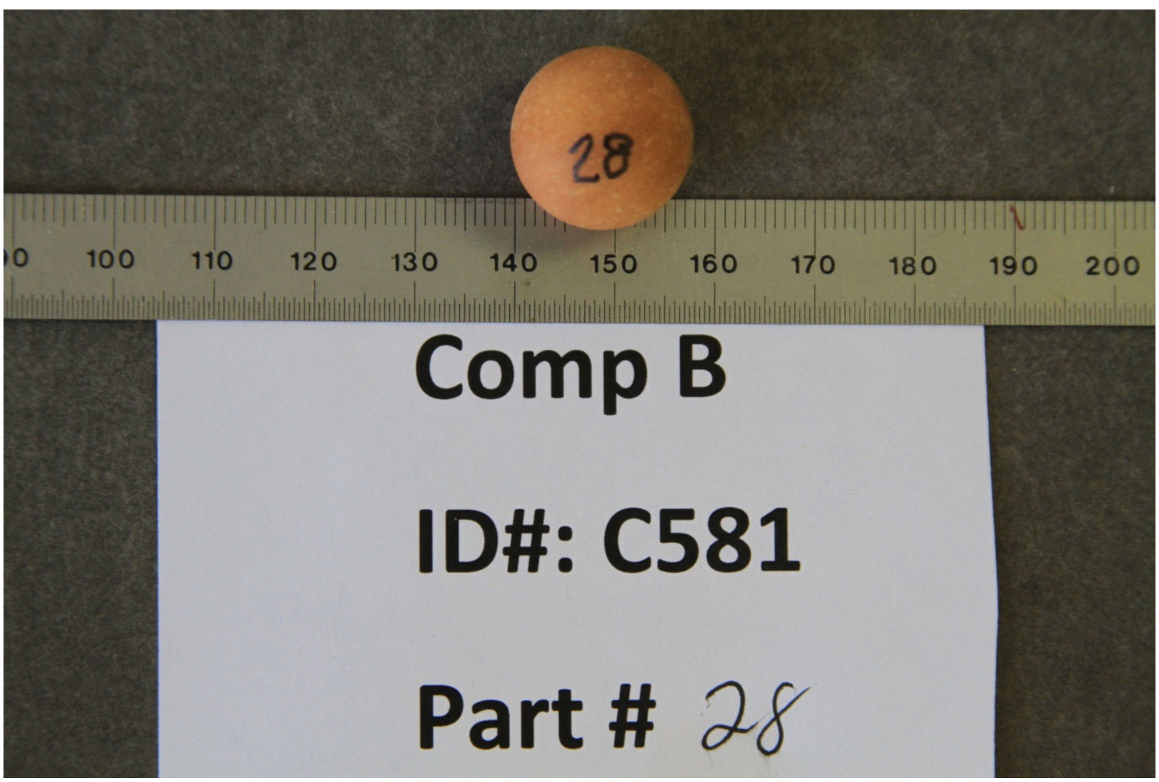
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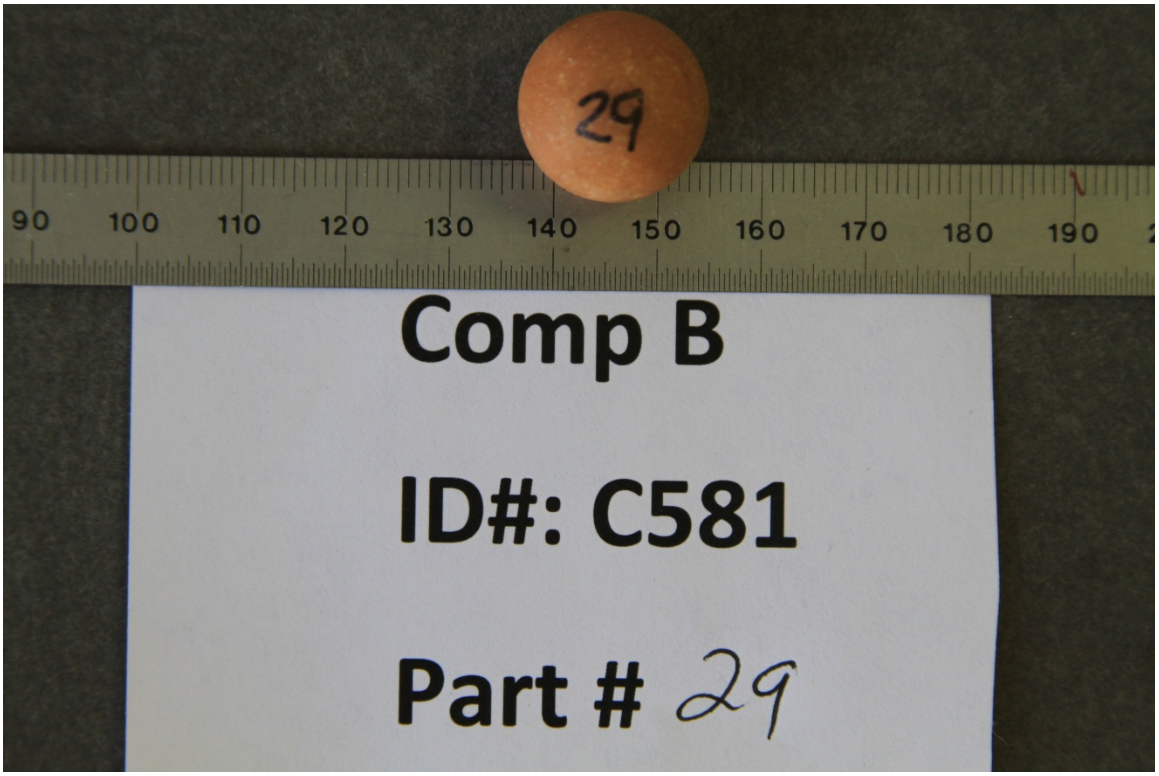
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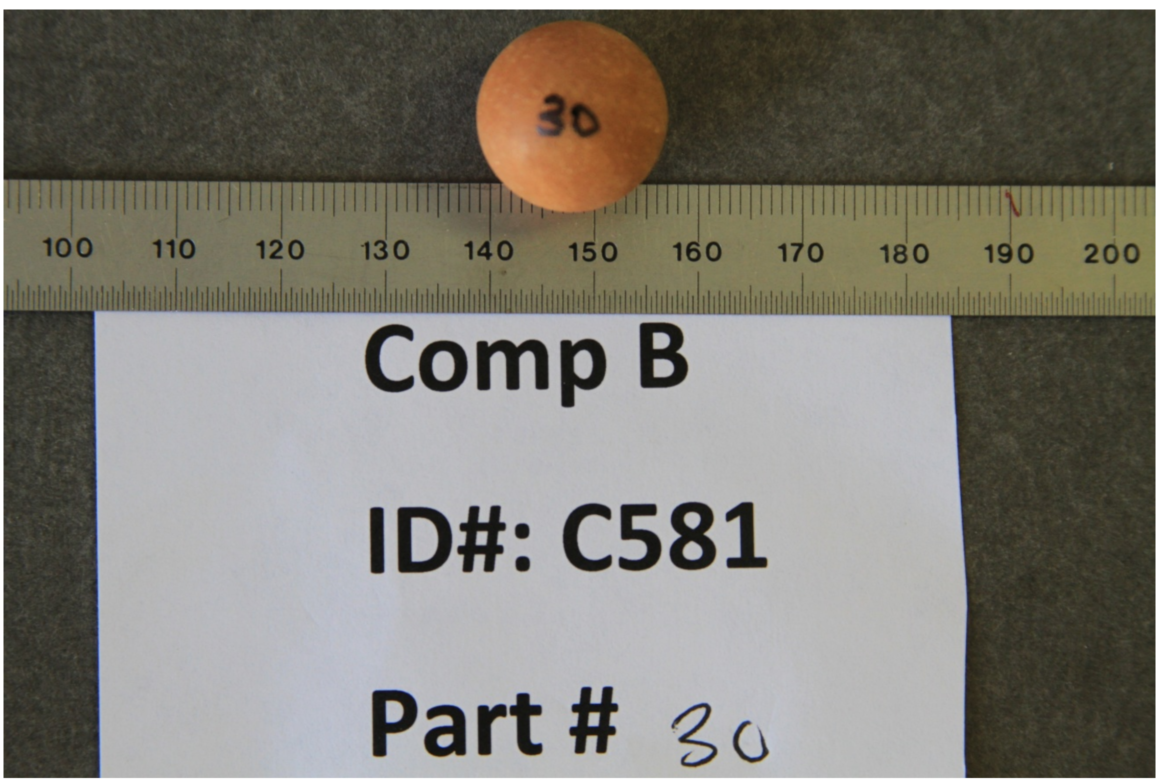
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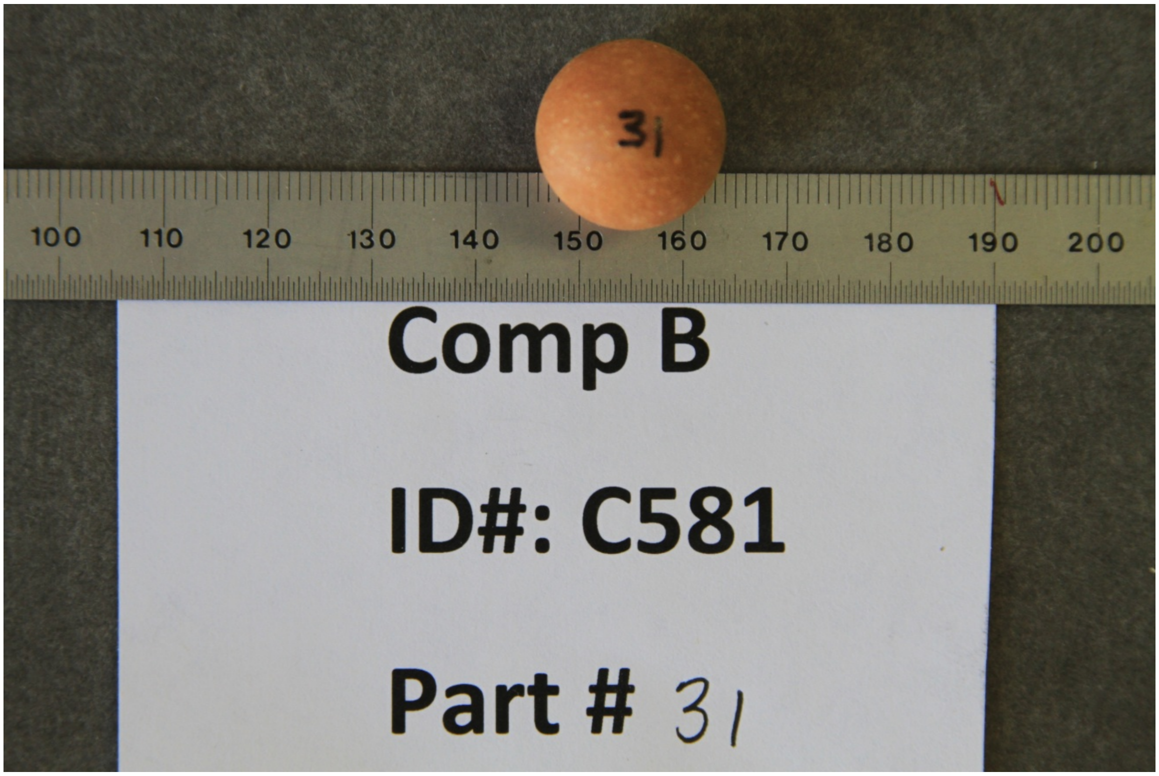
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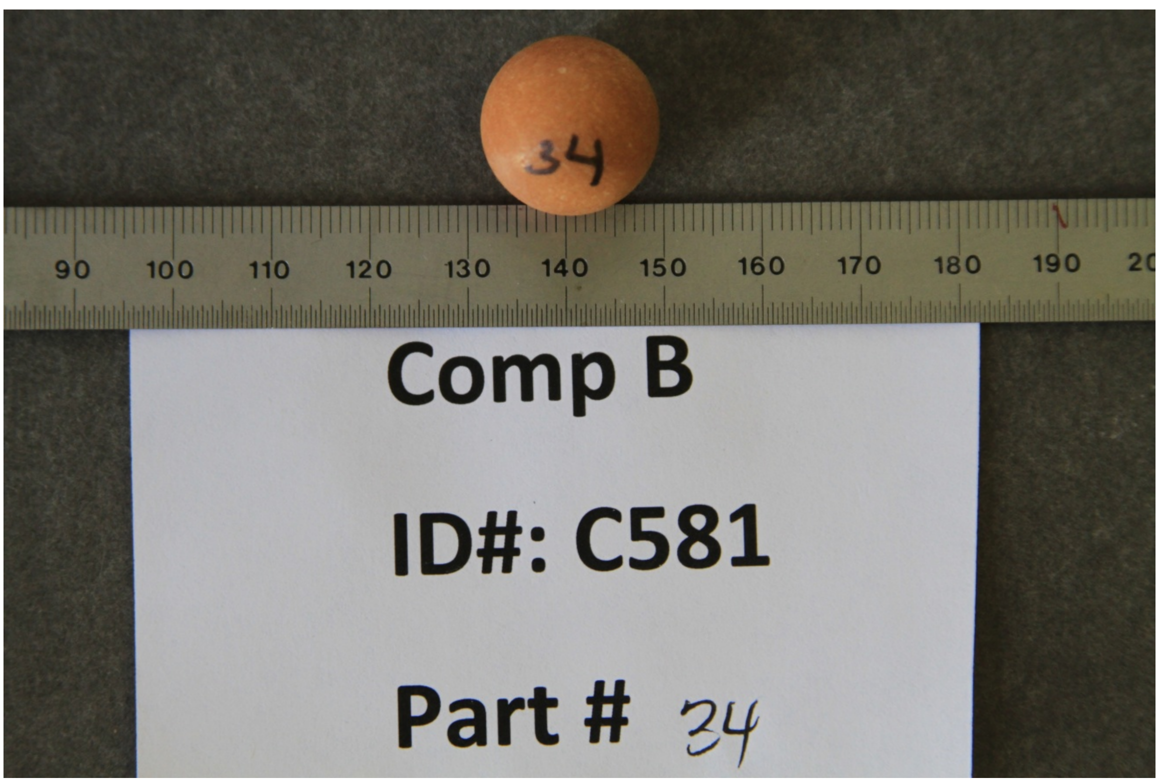
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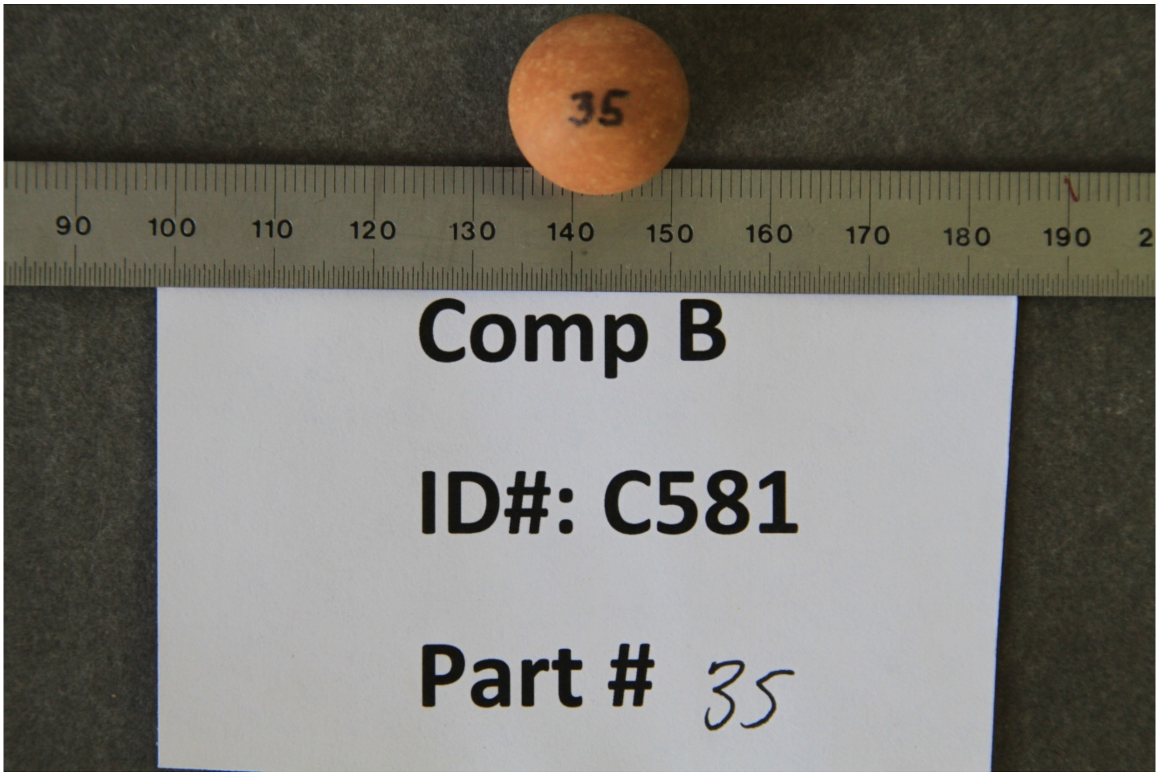
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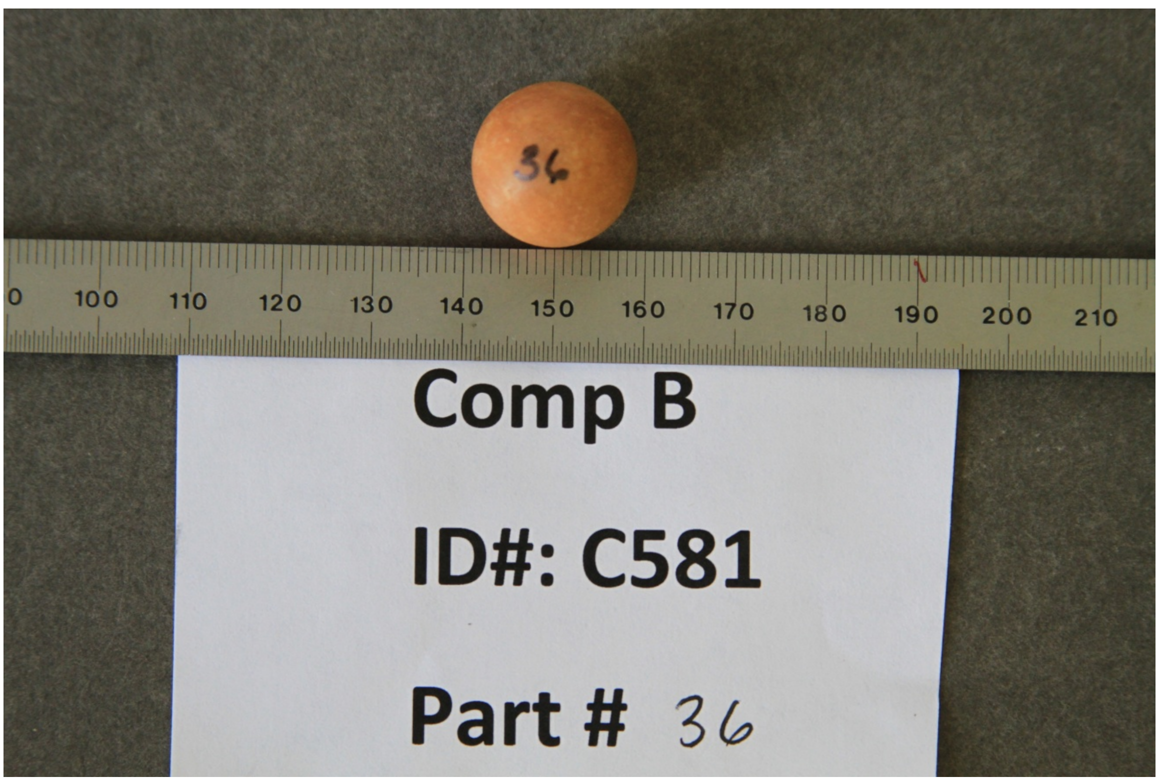
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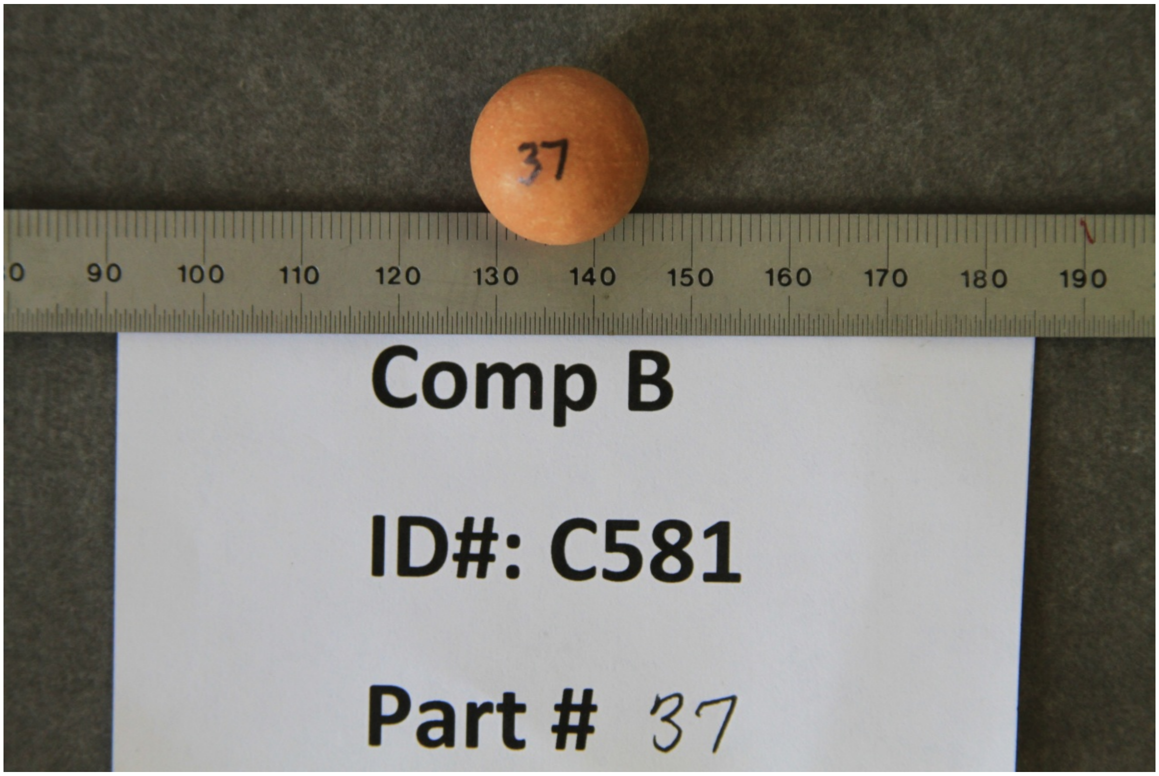
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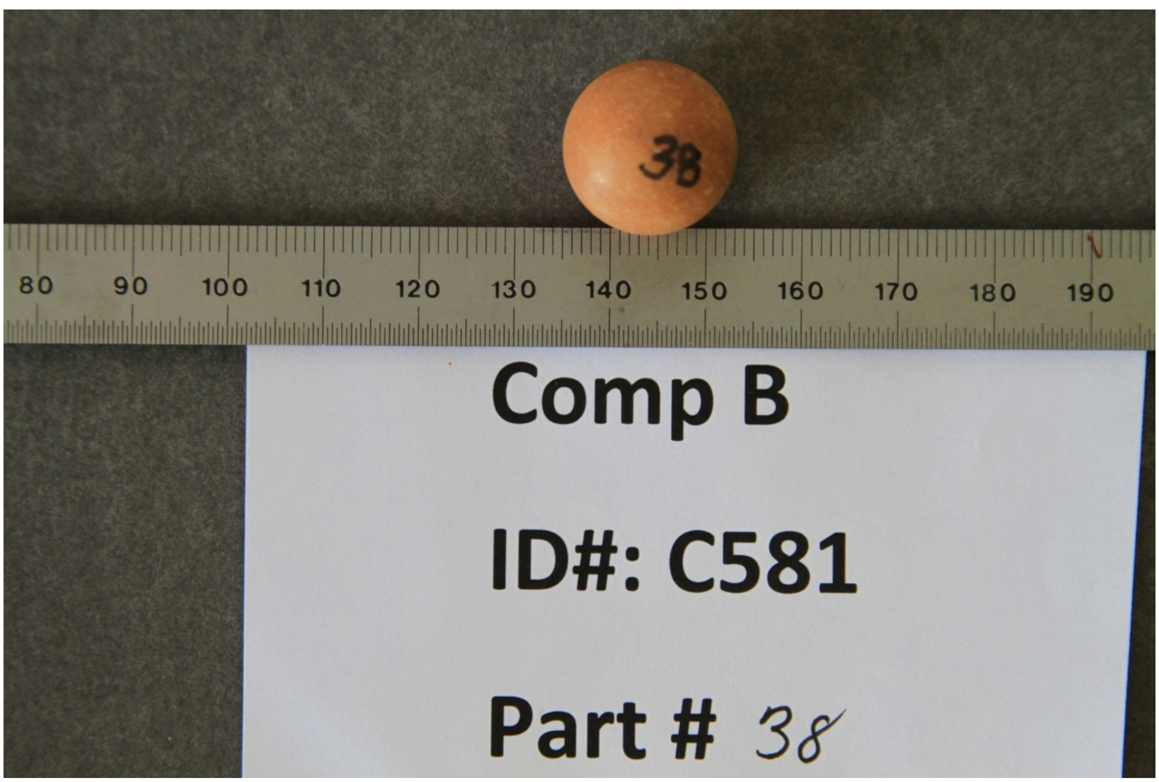
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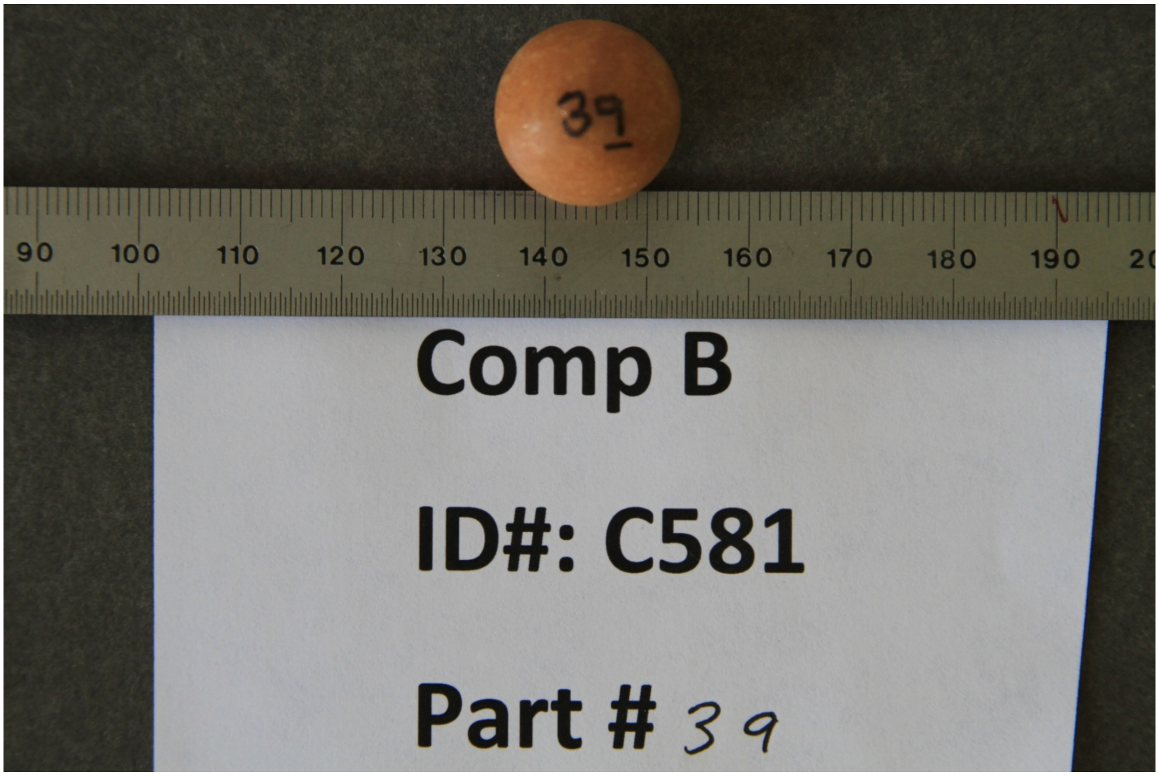
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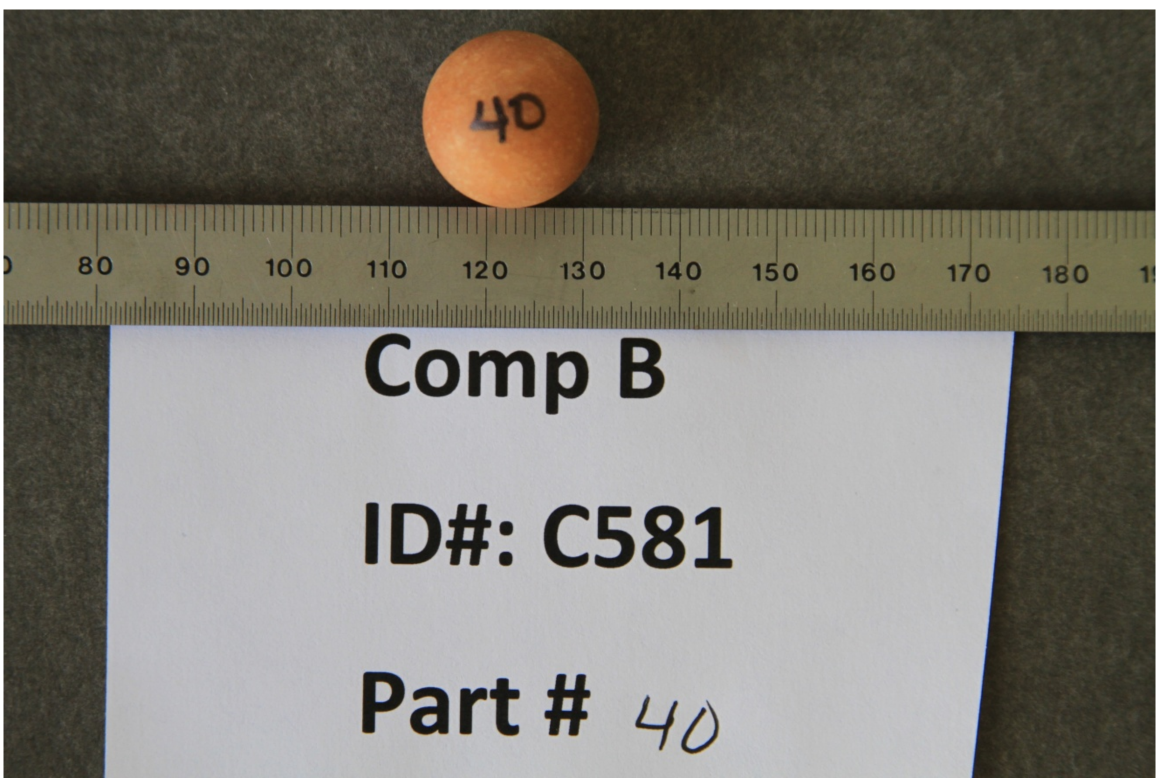
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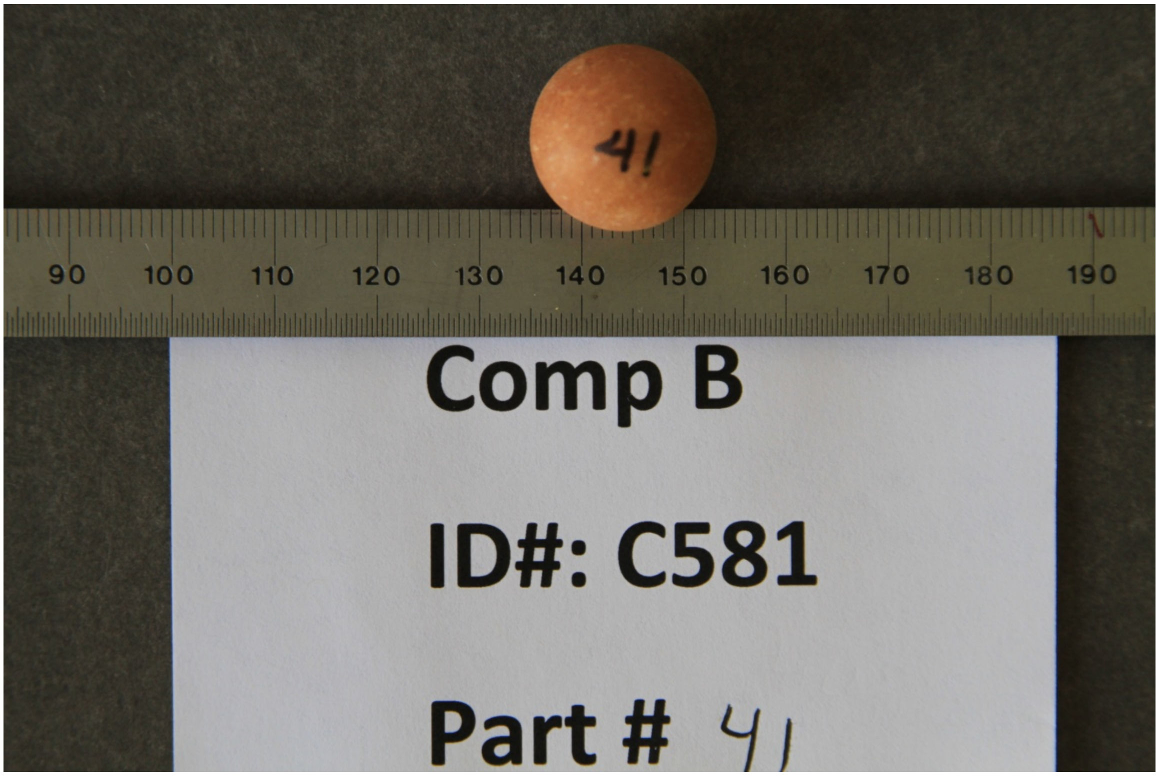
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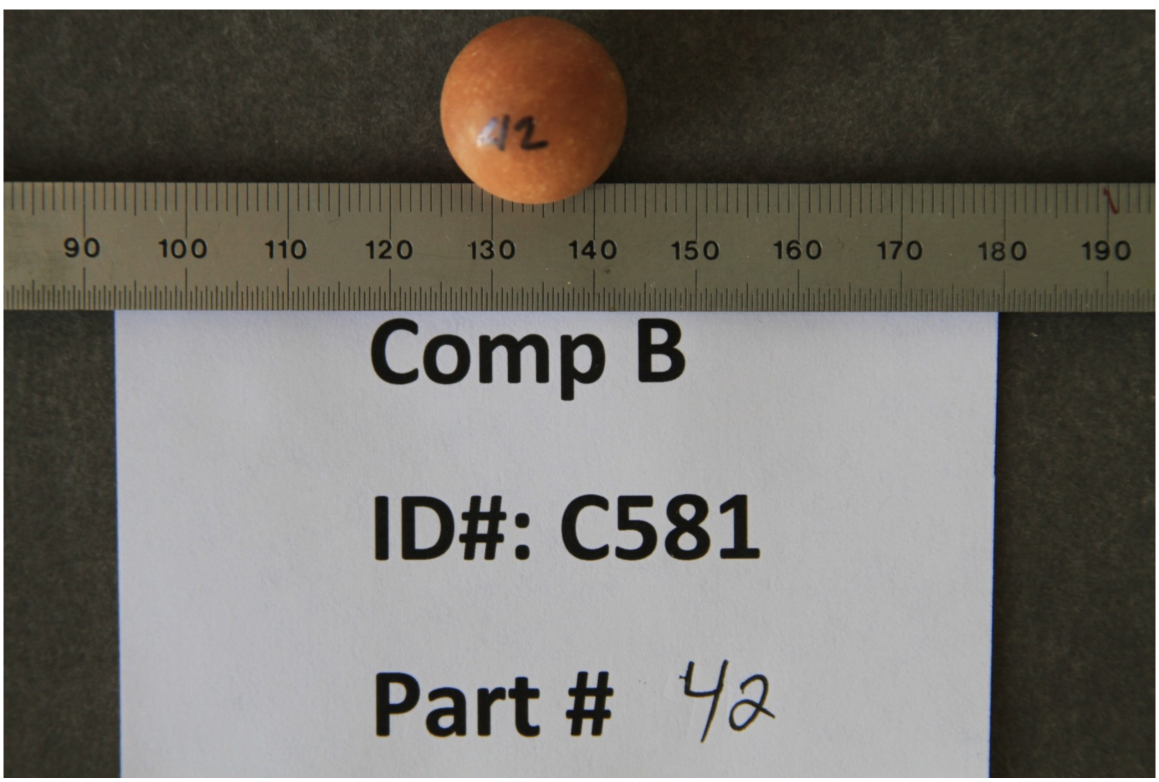
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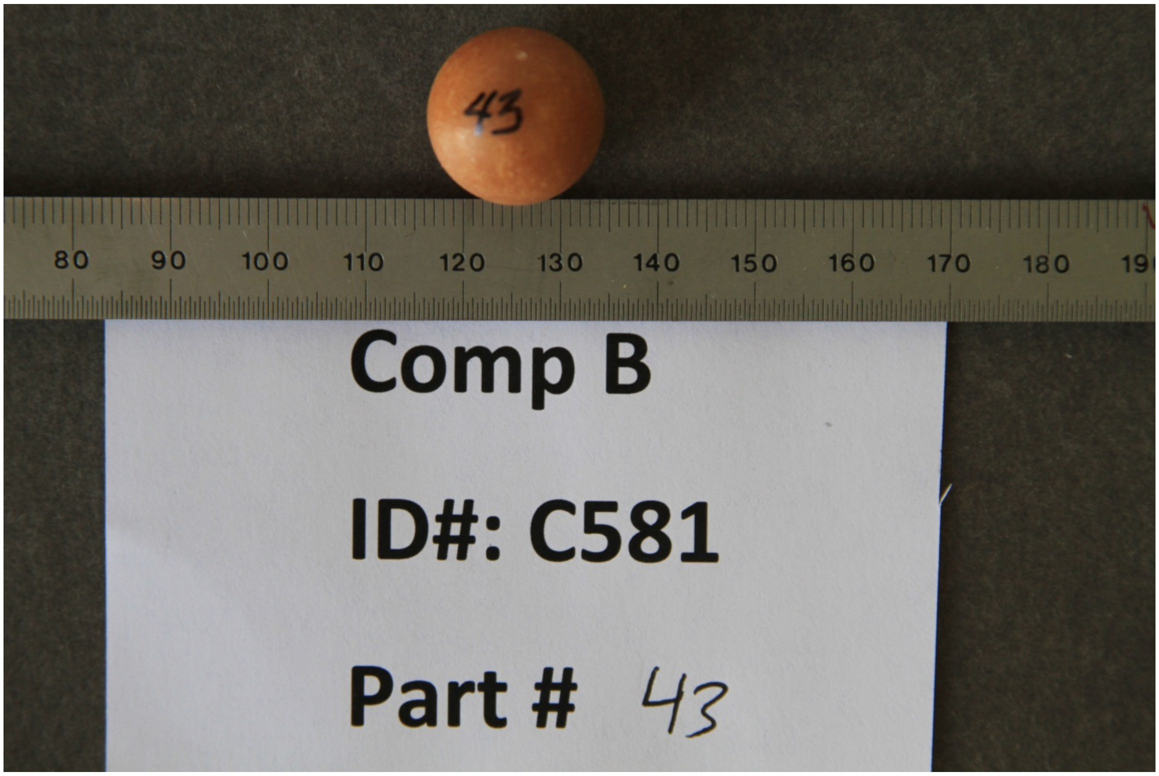
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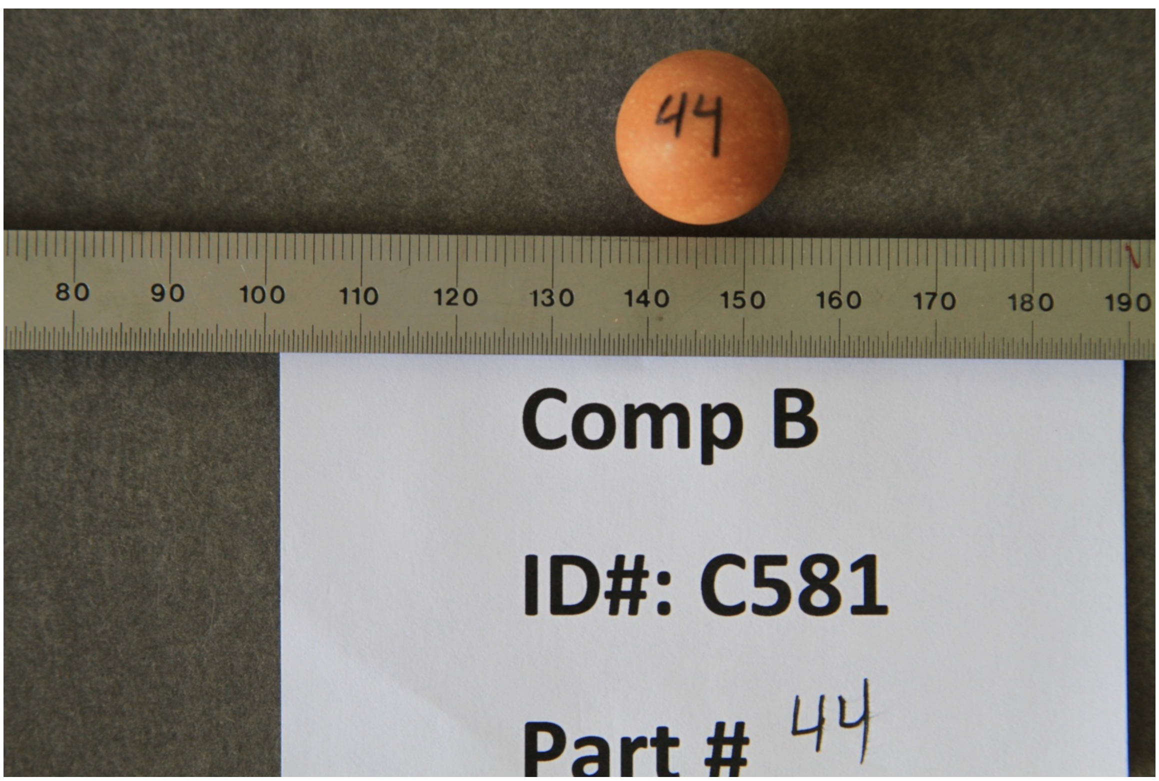
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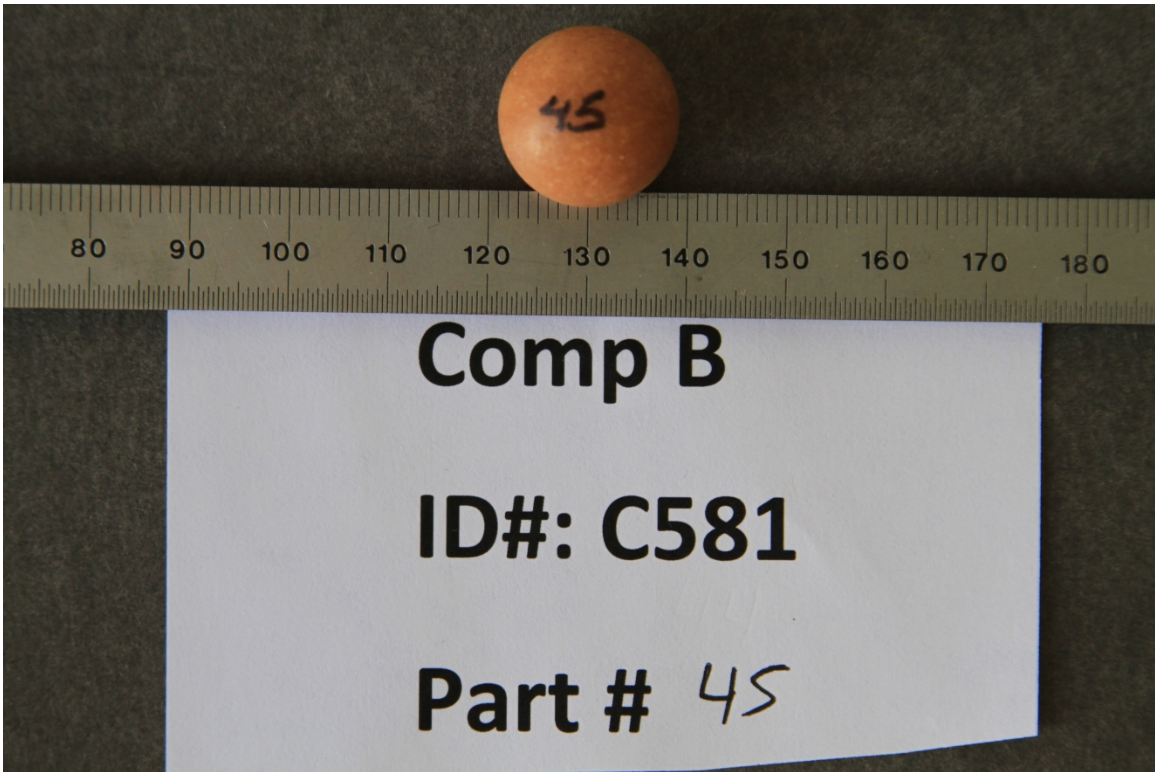
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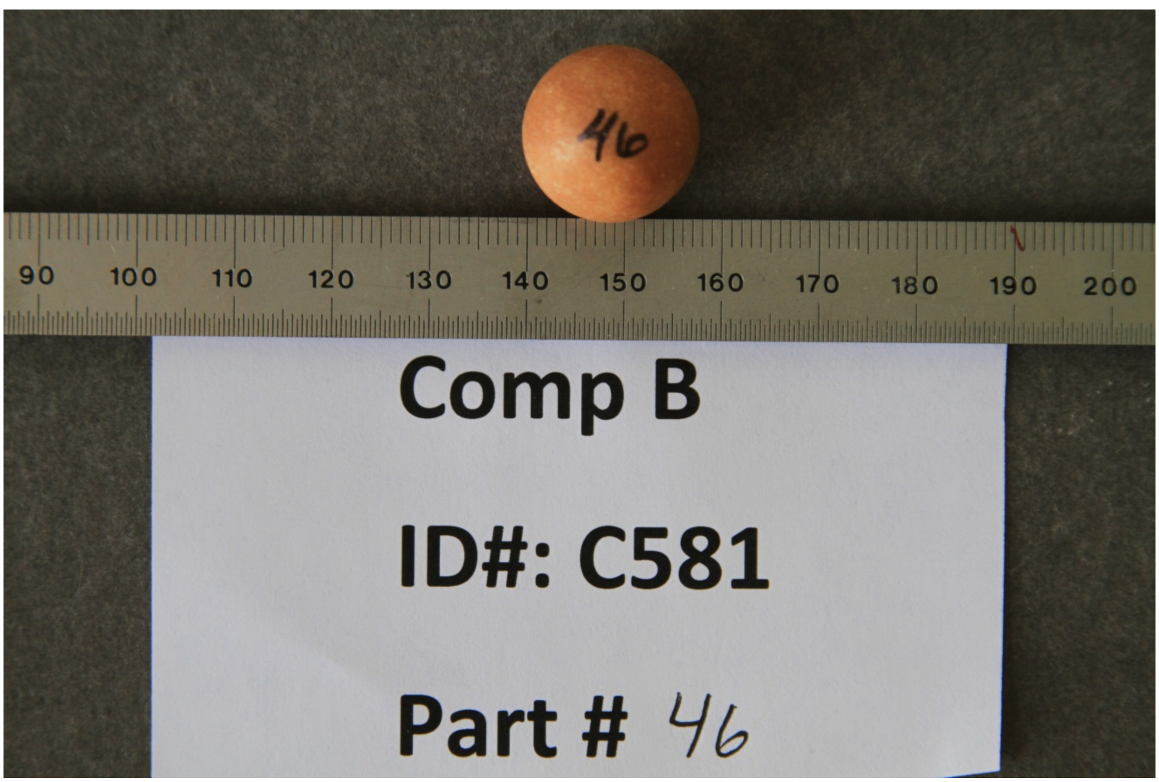
Part # 45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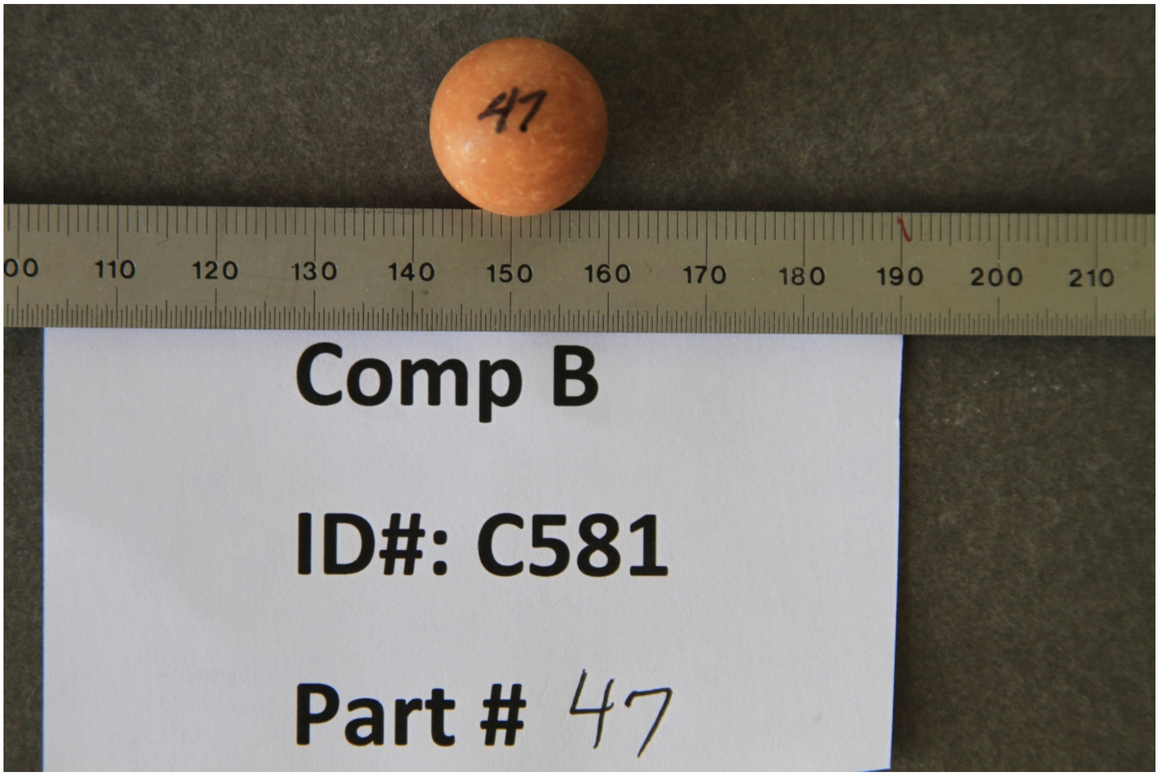
Comp B
ID#: C581
Part # 46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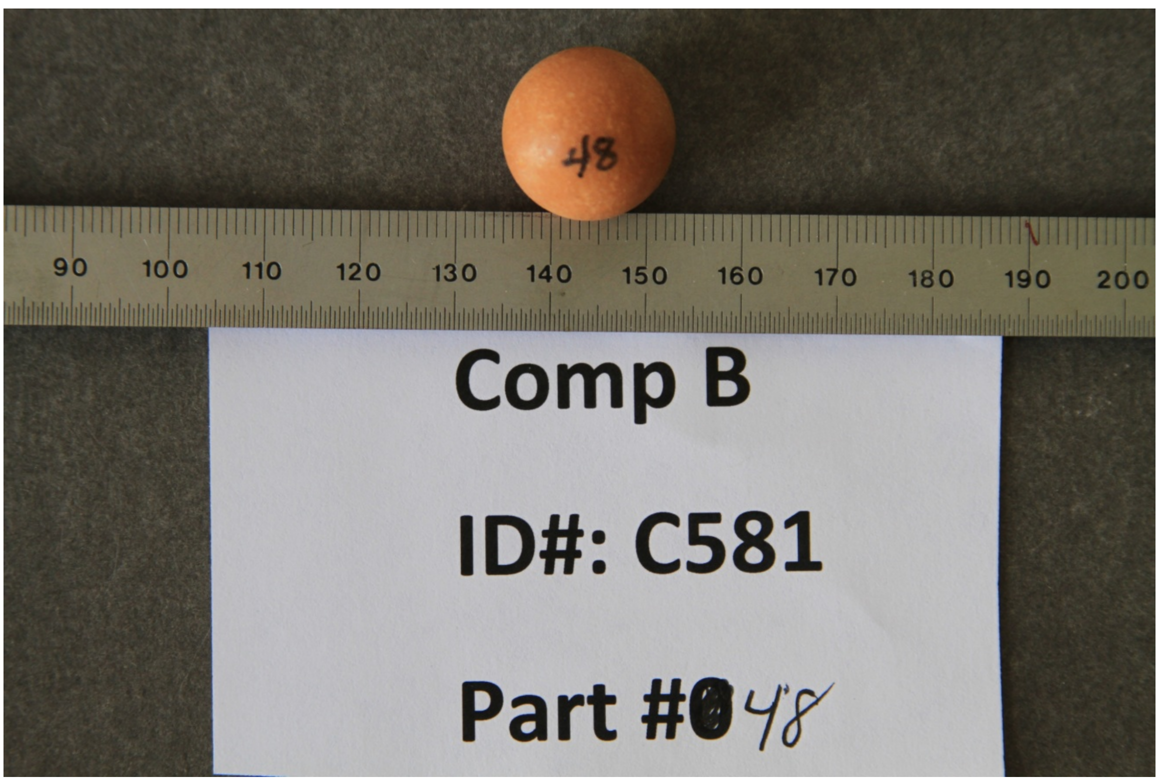
Comp B
ID#: C581
Part # 47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Comp B
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